Do you know why you smile?

SCIENCE DIGEST

JANUARY 1965 35 CENTS ICD

NOW—A HORMONE THAT MELTS AWAY FAT

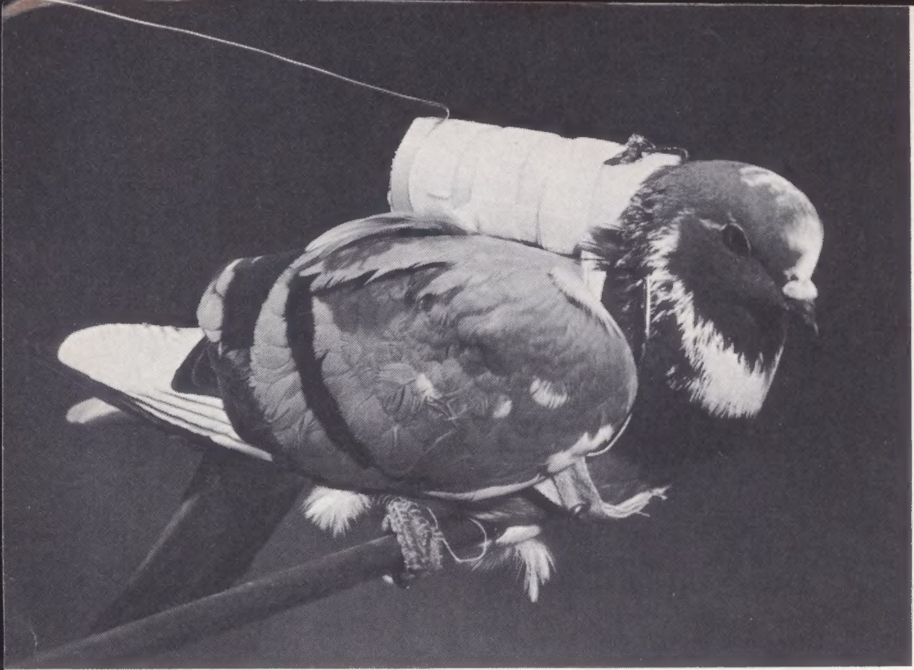
THE LAG IN U.S. INVENTIONS

WHAT IS A COMPUTER?

How it works, what it does— a new series

NEW TREATMENTS FOR ACNE

1965: YEAR OF THE SPACE TWINS



Radio-toting pigeon

A RADIO-TOTING pigeon flying at the end of a fishing line may sound a bit bizarre.

Yet there was Pigeon No. 13 (above) soaring happily along while a scientist of the National Research Council of Canada carefully reeled him back with a fishing rod.

Pigeon No. 13, despite his apparently unlucky number, is the top-flight research pigeon in a unique project under Dr. J. Sanford Hart, of the division of Biosciences. Its purpose: to elucidate mysteries of bird flight.

In flight, birds are known to generate very high body temperatures as a result of their intense activity. How do they get rid of this energy and exactly how much energy do they, in fact, produce?

Dr. Hart had tiny radio transmitters made and strapped to the pigeon's backs. As the pigeons fly, the transmitters automatically monitor three factors: heart rate, speed of wing beating and frequency of breathing.

Already interesting facts have emerged. When a pigeon sits on the ground, he takes about 25-30 breaths a minute. In flight, this steps up to a remarkable 500 breaths a minute. At rest, his heart rate is about 150 beats a minute; in flight, this jumps to 600 a minute.

"When we are through with a test series we just release the pigeons through a window," says Dr. Hart. "The trouble is, a lot of them come back. Now we don't know how to discourage them."

SCIENCE DIGEST

Twenty-ninth year of publication

The biggest U.S. space effort this year will be putting astronauts John Young and "Gus" Grissom into orbit in a two-man Gemini space capsule. A complete preview of this next phase in the race for the moon begins on page 48.

JANUARY • 1965 VOL. 57, NO. 1

SCIENCE THIS MONTH

SCIENCE PANORAMA

SCIENCE MISCELLANY

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U.S.-SOVIET DESALTING AGREEMENT. U.S. Ambassador Foy D. Kohler and Soviet Foreign Minister Andrei Gromyko formally signed an agreement that their countries would cooperate in developing ways of desalting sea water, including the use of atomic energy (see Science Digest, Aug '64). The agreement calls for exchanges of reports, joint technical meetings and reciprocal visits by experts to installations and labs in both countries.

The agreement was another in a long series. Gromyko recalled the test-ban treaty, also signed in Moscow, and other scientific-political agreements of the past few years, including the "hot line," the exchange of weather information, the decision not to put nuclear warheads in orbit and to reduce the production of fissionable materials. Gromyko proposed a toast to "a solution of unsolved problems."

The signing encouraged scientists who hold that science is truly international and that scientific agreements are one road to international understanding. The theory seemed to be working. Diplomats studied the desalting agreement as closely as did the scientists. They were looking for clues to the directions the post-Khrushchev leadership will take. The treaty was informally agreed to before Khrushchev's removal. Its rapid approval by the new leaders was viewed as a good sign.

DESALTING AGREEMENT WITH ISRAEL. America and Israel will begin a joint engineering study for a giant atomic desalinization plant to be built in Israel. The White House said the study, to be completed this year, will consider a plant that could provide up to 1 billion gallons of fresh water and 200,000 kilowatts of electricity daily. The Israeli plant would be a proving ground for large-scale desalting plants to be built in the U.S.

WHAT THE U.S. IS DOING ALONE. The Department of the Interior and the Atomic Energy Commission issued a special report in the desalting field. They urged the U.S. program be expanded from 1964's $12.5 million to $200 million in seven years. The report also had specific recommendations such as establishing a 50-million-gallon-a-day plant in the Southwest by 1967. President Johnson, who has often stated his interest in desalting research, went out of his way to praise the report. "We are going to ask Congress for some more money," he said. "This report will serve as a guide."

CHINA LEADS FRANCE? French President de Gaulle may feel insulted but many experts believe that the first Chinese nuclear blast (see page 10) used a more advanced "device" than any yet possessed by France. The French are rushing (at an enormous cost) to test an H-bomb by 1967. China may beat them to it.

INDIA SAYS NO. A lot of countries may have stepped up their nuclear weapons research since the Chinese test, but India, now China's bitter rival, has rejected building the bomb.

MARINER TO MARS. The second Mariner Mars probe for 1964 was delayed almost until it was too late while technicians tested a metal replacement for a fiberglass shroud to protect the vehicle during launching. The first Mars shot failed because the cover was not kicked free. At press time, the outlook for the second shot was uncertain. Plans called for the probe to pass Mars in July (see story, Rendezvous with Mars, on page 24).

FREE FLOATING COSMONAUTS. The three-man crew of the Russian spaceship Voskhod said they didn't use seat straps during their 24 hours in orbit. When they slept, they said, their arms were suspended vertically in the air. They did not explain, however, how they kept their bodies from floating around the cabin while sleeping, if they were not strapped in. Konstantin Feoktistov, the scientist in the crew, also said the craft had a new control system that made it possible to orient the vehicle even while on the dark side of the earth. The system used an ion engine, he said. The U.S. is also testing ion space engines.

U.S. SCIENTIST-ASTRONAUTS. NASA has issued invitations to scientists to volunteer for astronaut training. This year they expect to pick 15 to 25. Up to now all astronauts have been experienced jet pilots. But no scienti[illegible] that would be traversed by a ray of light in one second. . . .In these units, the cost of the OAO program is only 10 light cents and that of the manned lunar landing a mere 10 light dollars." Leo Goldberg in the Smithsonian Astrophysical Observatory News.

RACE AND SPACE. NASA boss James E. Webb said that research work may be shifted from Huntsville because of the difficulty in attracting top management executives to racially-troubled Alabama. Alabama officials claimed the move was politically inspired, but Webb denied this.

END FOR THE CONCORDE? For over two years Anglo-French cooperation on building a supersonic passenger plane was harmonious, marred only by an argument over whether to call the plane the Concorde, as the French do, or drop the "e" and call it the Concord, as the British do. Now the British may drop more than the "e"; they may drop the whole project. The Labour government feels the long-term commitment to the plane is too expensive. If Labour pulls out of the deal, as now seems indicated, France will be unable to go it alone. Nobody knows what de Gaulle will do to retaliate, but there is speculation that he will block the English Channel tunnel plan.

U.S. SST OUTLOOK. If the Concorde is scuttled, the U.S. will be the first country, at least in the West, to have a commercial SST. But many in the aviation industry are not too sold on SST and without competition from the Concorde the pace of U.S. development will probably slow down considerably.

rushing (at an enormous cost) to [illegible] bomb by 1967. China may beat them to it.

INDIA SAYS NO. A lot of countries may have stepped up their nuclear weapons research since the Chinese test, but India, now China's bitter rival, has rejected building the bomb.

LIGHT PRODUCES 'ECHO.' Using the light from a ruby laser under very special conditions Columbia University physicists have produced an effect called the "photon echo." Many scientists thought this complex phemomenon was not physically possible. It may have application in computer technology and give new insights in solid state physics.

PLEISTOCENE EPOCH LONGER. It is generally believed that modern man evolved from other species during the Pleistocene Epoch (the time of the ice ages). The Pleistocene was thought to have a duration of about one million years or less. This seemed uncomfortably short a period for all that evolution. Now scientists have constructed a new time profile from ocean bottom sediments collected by 44 different expeditions. The evidence indicates the Pleistocene was 1,500,000 years long, which confirms anthropological findings.

QUOTE OF THE MONTH: "The cost of launching several OAO satellites is estimated at about 200 million dollars....these numbers are becoming so large that it may be necessary to adopt a new unit for money. Just as the light year replaced the kilometer or mile, I suggest that we may have to adopt the light dollar as a unit for the space budget. One light dollar is the number of ordinary dollars laid end to end that would be traversed by a ray of light in one second. . . .In these units, the cost of the OAO program is only 10 light cents and that of the manned lunar landing a mere 10 light dollars." Leo Goldberg in the Smithsonian Astrophysical Observatory News.

WONDER OF THE MONTH

Laser revolution in 3D photography

When Emmet N. Leith and Juris Upatnieks, two physicists at the Institute of Science and Technology of the U. of Michigan at Ann Arbor, want a duplicate of one of their 3-D slides, they simply cut it in half.

If they need four copies, they cut it in quarters.

The rule is: to multiply, divide. Each piece gives a complete picture, although as the piece grows smaller, details become blurred.

This is just one of the "startling effects" Leith and Upatnieks claim for their pictures taken by laser light. The special nature of laser light enables them to combine information about the shape and shade of an object, as seen in an ordinary photograph, with a sort of a radar record of the distance of the various parts.

Here are principles involved:

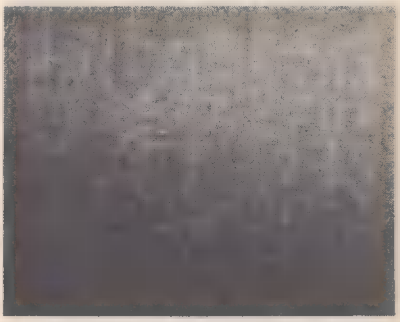
The filament in an ordinary light bulb emits frequencies or colors covering the whole spectrum. Many atoms in neon tubes or sodium vapor lamps emit the same frequency or color, but not in step. They are like 100 phonographs playing different parts of the same Beatles record. A laser emits a single frequency, and what is more, the atoms of the ruby or gas in the laser work in perfect unison, so that wave fronts stream out the end like rows of soldiers on parade.

Leith and Upatnieks bounce laser light from the object to be photographed directly onto film. They need no lens. Part of the beam is also reflected onto the film from a mirror. Light that has bounced from a particular spot on the object will have travelled a different distance to reach the film than the light bounced from the mirror, and the waves may no longer be in step. Or the distance difference may be just equal to one or more wavelengths and the wavefronts will arrive at the film back in step. Where the waves arrive in step they will combine their energies into a bright line. Where they are out of step, they will cancel each other along a dark line. The final photograph looks like a picture of a calm pond in a summer shower.

Unlike ordinary photography

Light from every point on the object has reached every point on the film. It hasn't been focused to one point as in ordinary photography. That is why each piece of the film carries all the information to make a complete picture.

Both bottom pictures are stored in the transparency at top. If the transparency is projected by a diffused laser beam, each picture shows up when the screen is set at a different distance. The transparency records interference rings formed when laser light bounced from the photos meets that reflected from a mirror. One or more 3-D pictures can be taken in the same way.



The two physicists view their 3-D pictures by shining laser light through the back of a slide and looking down through it at an angle from the front. The image appears behind the transparency. Is an object in the way in the picture? They can simply move to the side and look around it.

Several three-dimensional pictures can be mixed on the same transparency. Different images appear at different viewing angles.

Likewise, photographs of several two-dimensional objects can be combined. To make them visible, the slide is projected on a screen by laser light. As the screen is moved away from the projector, different pictures form and dissolve.

Laboratory table tops will probably be the favorite subjects for a while. Present lasers are so weak they can light only small scenes at long exposures. And it takes a physicist to set everything up.

THE NUCLEAR STORY

Not-so-backward China

Wide World

NO ONE laughed when the Chinese Communists exploded their first nuclear device last October, but there was an immediate tendency in the West to downgrade its importance. The public gained the impression that the Chinese device was primitive, and that the U.S. knew just exactly what stage Chinese nuclear development had reached.

But analysis of the radioactive debris of the Chinese blast provided some sobering surprises. The test device, it was found, was built of enriched uranium, not plutonium as had been presumed.

Enriched uranium is more difficult to produce than plutonium.

Another surprise was that the device seemed to have been triggered by a relatively advanced and difficult implosion technique.

The Atomic Energy Commission found the bomb was "roughly equivalent" to the Hiroshima bomb (20 kilotons or 20,000 tons of TNT). But it noted that the Chinese device was "somewhat more advanced."

Dr. Philip Abelson of the Carnegie Institution of Washington notes that the Chinese have apparently mastered the technique of separating weapons-grade fissionable U235 (enriched uranium) from nonfissionable U238 in mined uranium.

This gives them, Dr. Abelson writes in the magazine *Science*, a greatly enhanced capability of producing tritium, a key constituent of thermonuclear bombs.

"If the Chinese do not now possess quantities of tritium, they can obtain it. In view of the Chinese achievement thus far, there is no basis for hoping that they will not achieve a hydrogen bomb—perhaps in the latter part of this decade."

The Chinese Communists said that their nuclear explosion "shocked and irritated the U.S." They are right.

INVENTIONS PATENTS PROCESSES

Glass submarine

Glass materials are stronger the deeper they go into the ocean depths, as they don't fail under compression.

An underwater research vehicle designed to dive more than 30,000 feet under the sea will have a glass hull that will get stronger the deeper it goes. The hull will be made of Pryoceram glass-ceramic by Corning Glass Works. The free-diving vehicle has been named *Benthos*, a Greek word meaning deep-sea bottom dweller.

The eight-foot-long, torpedo-shaped *Benthos* is planned as the first of a series of glass and ceramic unmanned oceanographic capsules probing the sea's depths.

The hull of *Benthos* will consist of four glass-ceramic cylindrical sections. Pryoceram glass-ceramic was chosen as the hull material because of its comparative strength, which is higher than 300,000 pounds per square inch. The material doesn't fail under compression, thus gets stronger the deeper it goes. The theoretical strength-to-weight ratio of the glass-ceramic is higher than that of high-strength aluminum and steel alloys now used for underwater vehicles.

The relatively light weight of the glass-ceramic will help give *Benthos* a buoyancy of approximately 60 percent of the displaced water. Only a glass material could allow so much buoyancy in a deep-submergence hull with a depth capability in excess of 30,000 feet.

Using the sun's energy

The world's largest solar tracking facility, designed to test various solar-energy collectors that could produce electrical power for long space missions, has been designed and constructed by Sundstrand Aviation-Denver under the direction of the Air Force Aero-Propulsion Laboratory.

The three-story facility houses a giant 45-foot parabolic mirror that

The concentrator, which produces temperatures above 2,000°F, can melt a hole in an aluminum disc within seconds.

can produce temperatures estimated in excess of 2,000° F at its focal point. This heat, if transformed into electrical power, could meet the daily electrical needs for 30 average American homes.

A spokesman for Sundstrand described the solar tracking facility as a major step in a long-range program to develop a system for providing continuous electrical power for future manned and unmanned space missions.

In operation, solar sensing devices will keep the 22-ton rig in perfect alignment with the sun.

The 45-foot concentrator will focus the intense rays of the sun into a spot approximately eight inches in diameter. The searing heat could be used to boil a working fluid, such as water, to produce high-temperature steam or vapor to drive a power-producing turbine.

A new movable acoustical room, lighted, portable and sound-proofed, was purchased for New York's LaGuardia Airport runways.

Runway traffic control room

One of the taxiways at New York's LaGuardia Airport has an unusual octagonally-shaped room sitting on it.

As planes taxi toward maintenance areas, they must cross a busy roadway leading to the Marine Air Terminal. To control traffic, both planes and automobiles, a police officer is on duty 24 hours a day. A new movable acoustical room, lighted, portable and sound-proofed, was purchased from Industrial Acoustics Company, Inc., New York, to house the police officer, his radio, telephone and desk.

The room is easily moved from place to place by means of a forklift truck via built-in slots and gives the police officer the shelter and facility he needs for effective control; 360-degree vision allows him to see in all directions and acoustical performance allows him to hear above the engine noise.

Spray-on sausage skins

Although sausages are usually made in strings, individual sausages, each coated with a sprayed on vegetable casing, can be produced by a machine designed by P. H. Hilgeland of Foodtech Limited, Harringay, London, N8.

With this invention, the sausages come off in a continuous stream, each enclosed in a clear and tender skin that is tasteless and does not burst when cooked. The skin is made from vegetable materials.

The use of vegetable casings is said to result in a 95 percent saving over animal casings. They are also reported to be more hygienic and help keep sausages longer.

How to steer a parachute

A technique of using a knife to change the shape of a parachute in mid-air will soon be taught all Air Force crews in an effort to reduce injuries from parachute landings. Developed in 18 months of tests at Wright-Patterson Air Force Base, Ohio, the procedure modifies the chute's handling qualities so that it glides as well as descends, is steerable and less subject to uncontrolled swaying.

With a steerable chute, the Air Force believes an airman bailing out of his plane in an emergency will be able to pick his landing spot and avoid trees, high-tension lines and other landing hazards. He will have a better chance of landing on his feet, instead of an off angle.

The technique requires the airman to reach up and sever four of his chute's suspension lines. This is to be done immediately after he "hits the silk," but not below 500 feet. This causes a large opening to form in the rear center of the canopy. Air trapped in the chute spills out the opening, producing forward speed, a means of steering and more stability.

Revolutionary textile development

What has been touted as the greatest development in the art of weaving since the invention of the power loom in 1785 is now being used to produce blankets. The process turns fibers directly into cloth and bypasses all conventional yarn making and weaving processes.

The new process called "fiber-woven" uses a patented "needle loom" and has a very high rate of production, about 20 times as fast as conventional looms. It can be used to make many types of heavy and medium weight fabrics, and will probably have a great effect on the entire textile industry.

Although the method is called weaving, it is really based upon the needle punch technique of fabric production. A matt or batt of fibers is passed through a machine called a needle-punch loom. Barbed needles continuously pass through the batt locking the fibers together.

Such products have been made in the past but they generally had to be reinforced by binding agents

which made them stiff. The new process does not need these adhesive bindings.

Dr. Alexander Smith, inventor of the process, says, "Just as in conventional fabrics woven of twisted yarn, the fibers (in fiberwoven fabrics) are held together by friction which develops when a pull is applied. Just as in conventional woven fabrics, softness and desirable hand also are possible since, at rest the individual fibers are substantially free and can flex."

The manufacturers claim that blankets made by the new process will be 15 to 20 percent warmer than conventional blankets due to the homogenous spacing of the fibers without the spaces occurring between yarns in loom woven cloth. The fiberwoven fabrics are also described as lighter and stronger.

Meters read by telephone

The technical feasibility of reading residential gas and electric meters over telephone lines was established in a recent field test conducted by General Telephone of Michigan.

During the 16-month test in Owosso, Michigan, utility meters in both apartment houses and private homes were read automatically by an experimental electronic system attached directly to the meters. A special device was placed on the meter so that it could be called electronically using standard telephone company equipment and lines. The meter "answered" the phone call by sending its reading back over the telephone line to a data receiver. After processing, the date was fed to a computer that automatically figured the amount owed and typed the customer's bill.

Cool, clear water

A water-cooled space suit developed by Britain's Ministry of Aviation is being used as a basis for designing clothing for U.S. astronauts in the Gemini project. This is the American two-man space flight which will precede an attempt on the moon.

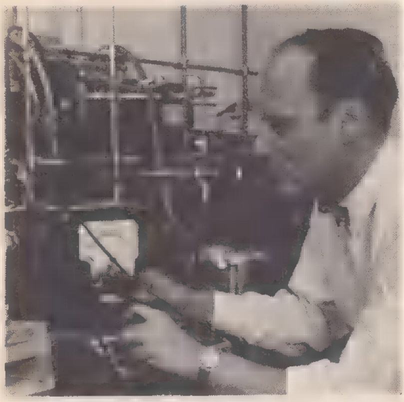
The suit is a one-piece undergarment which contains a network of small tubes in contact with the wearer's skin. When cool water is pumped through the tubes, heat is collected by direct conduction from the skin and through the tube walls. The water warms up a few degrees and is pumped from the suit through a heat sink for cooling, and back into the suit in a closed circuit.

The heat sink is charged with an expendable coolant such as ice, and the fluid motion is induced by a miniature electric pump. The power requirement is less than one watt, so the pump and battery weigh relatively little.

Advantages claimed for this system over air-cooled suits are that liquids are better heat-transfer agents than gases. Only a moderate flow is required; bulk is small; there is a small pressure drop across components; the power requirement is small and there is no noise.

INVENTOR OF THE MONTH

How to spot a sub



RADAR doesn't work through water, so it is impossible to "see" a submarine by that means from the air. But Robert H. Rines discovered many years ago that radio waves reflected from the surface of the sea performed almost the same function —they disclosed the telltale vibrations given off by a submerged body.

The *Science Digest* Inventor of the Month recently received Patent 3,153,236 for his submarine detection method, 21 years, 3 months and 20 days after he filed the application. It was delayed because of military secrecy.

The long pendency did not quite set a record, for other war-time inventions have been similarly delayed, but it was seven times the average period from filing to issuance.

Rines says the Navy and other services are using his invention. The equipment, carried in an airplane, analyzes the echoes from its own radio waves. The reflections show modulations caused by sonic or ultrasonic vibrations from a submarine's movement and machinery. The location of the vessel is indicated by the point from which the strongest modulations come.

Any spurious signals, such as those caused by water-waves, fish, shrimp and other sea life, can easily be distinguished, according to Rines.

The inventor, a Boston attorney who lectures on patent law at Massachusetts Institute of Technology, first noticed the modulation effect when he was an M.I.T. undergraduate in 1941. After he became a Signal Corps officer, he continued study of the phenomenon outside official duty hours.

The original application, filed in 1943, included an antenna for which Patent 2,539,476 was issued in 1951. The Patent Office decreed that the submarine detector be split off and treated as a separate case.

Rines, at 42, holds about 40 patents, mostly for electronic developments. A spokesman for inventors and advocate of innovation (putting inventions to work), he has been critical of managerial indifference to creative ideas and creative personnel. His recent book is "Create or Perish, the Case for Inventions and Patents."

Recently he asked a business group, "How many industries today are living off the brains of just one man, Thomas A. Edison?" He doubted that Edison could get past his auditors' personnel directors.

—*Stacy V. Jones*

THE MEDICAL PICTURE

Instant stroke diagnosis

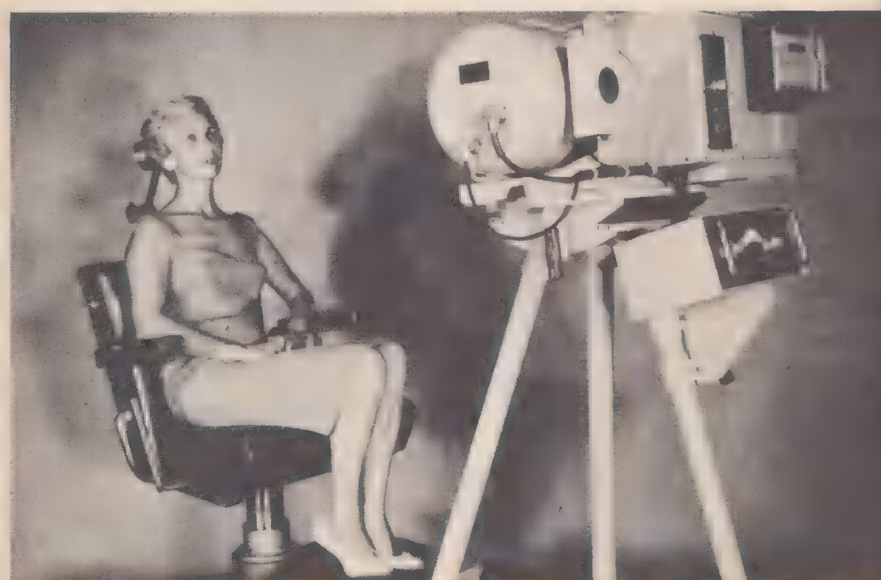
STROKES are third on a list of causes of death in the United States. They cripple over 1½ million Americans every year. When a doctor suspects his patient has had a stroke, he rushes him to the hospital for several days' treatment.

That may no longer be necessary.

A simple and surefire method of detecting strokes (extracranial carotid disease) in a five-minute test in a doctor's office has recently been announced by Dr. Ernest H. Wood, a University of North Carolina radiologist.

The method employs thermography, a new medical procedure used to record the radiant heat emitted by the skin, and, indirectly, the blood supply, since the blood carries heat to the skin. By applying an infra-red scanning device to the forehead of the stroke victim, cool spots, or areas of insufficient blood flow, are indicated on a thermogram, a graphic recording of

Preparation required for the thermographic test is exposure of the face to cool, dry air (70°F to 72°F) in a draft-free room for ten to twenty minutes. Then the patient is seated a few feet away from the thermograph while the picture is taken on Polaroid film.



the patient's forehead temperature.

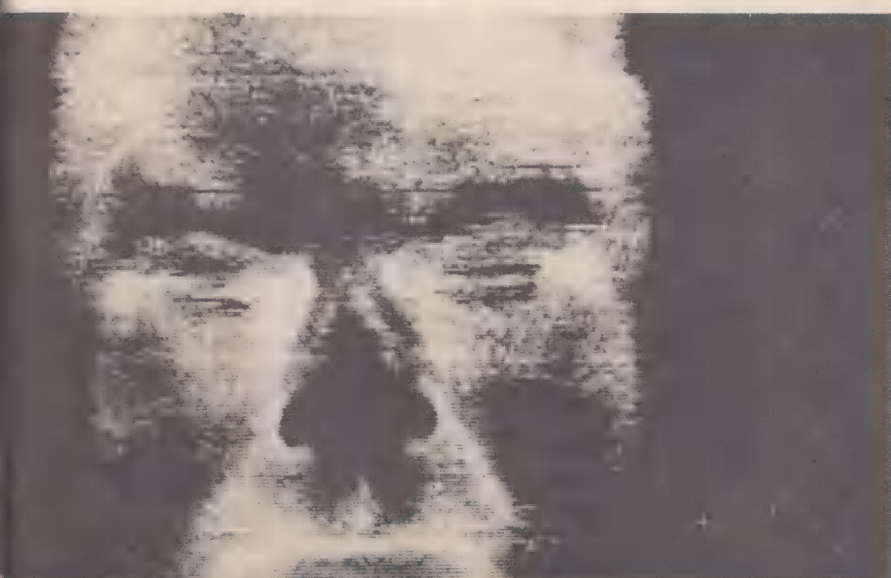
In tests of 700 normal subjects, the temperature on both sides of the forehead was found to be identical (light). Stroke victims, on the other hand, revealed a cool (dark) spot over one eyebrow, indicating failure of enough blood to surge through the carotid artery on that side of the head and neck.

According to Dr. Wood, the thermographic test is a fairly routine matter. The only preparation required is exposure of the patient's face to cool, dry air (70° F to 72° F) in a draft-free room for ten to twenty minutes. Then the patient is placed a few feet from the thermograph, and the picture is taken.

In their studies of healthy subjects, Dr. Wood and his associates found that facial thermograms of normal persons are dark over the nose, cheeks, the avascular corneas, eyebrows, eyelashes and scalp. Light areas appear over the anterior portion of the forehead. Among patients with cerebrovascular disease, they found a dark spot extending upward and outward from the nose. Stroke victims who have undergone successful surgery develop normal thermograms.

The heat screening machine used by the North Carolina investigators, Dr. Wood and his assistant, Dr. Richard P. Hill, is a commercially available model.

Poor blood supply shows up in this infrared photograph as a dark area over the patient's right eyebrow. This "failure" was causing some weakness in his left hand. In normal thermograms, cool cheeks, nose, eyes and hair-insulated areas are dark.



INSIDE PSYCHIATRY TODAY

The computer age in psychoanalysis

By Flora Rheta Schreiber and Melvin Herman

WHEN Dr. Joseph Jaffe, a Harvard Research Fellow and head of research of the William Alanson White Institute, announced that he was experimenting with the use of computers in psychoanalysis, it sounded like something more appropriate to a cartoon than to serious consideration.

This, however, is no laughing matter, as he recently demonstrated at a meeting of the White Institute that we attended. It's located in New York City. He began by asking us to name the essential features of a sentence pattern. The pattern consisted of these eight sentences:

(1) I always admired my mother. (2) Mother and I never confided in each other. (3) I once taught my father the Twist. (4) Will Mother ever be nice to me? (5) Father thinks I'm devilishly clever. (6) I once called Mother a bad woman. (7) I never told Father the truth. (8) Father wants me to be a model railroad buff, the way he is.

Pointing out that these simple sentences could be repetitive themes lifted from the psychoanalysis of a young woman, Dr. Jaffe showed how, when taken together, they illustrated an important pattern of relationships in her family. What, he asked, are the essential features of this pattern?

The answer is, as you have probably surmised, that quite a few of these statements are narcissistic indications of unresolved oedipal problems.

What the woman said, however, is only part of her story. The other part—equally, perhaps more important—concerns what she didn't say. To look for this unspoken material, as Dr. Jaffe made abundantly clear, is a large part of the psychiatrist's task. Significantly, for instance, the woman never mentioned her mother and father in the same sentence.

A psychiatrist, being human, might not notice the telltale omis-

Miss Schreiber is an award-winning writer on psychiatry; Herman, the Executive Secretary of the National Association of Private Psychiatric Hospitals.

sions until perhaps the tenth or eleventh session. "Human beings," says Dr. Jaffe, "notice what is there, but computers can pick up what is missing." Likening this process to Swiss cheese and the holes in the cheese, he maintains that the psychiatrist can often learn more from the holes in the cheese that the computer records than from the cheese itself, his notes.

The future may see all analytic sessions taped and key-punched to be recorded by a computer, with the analyst asking questions and the computer running through the millions of words in a jiffy and providing him with answers neatly recorded. Computers will then tabulate and classify sentences revealing human emotions and conflicts as the patient utters them.

The computer will give the analyst a new dimension with which he can delve into the verbal content of his patient's utterances, smashing their semantic structure.

It should be pointed out that this method, though given a mechanistic prop, is not essentially different from what the analyst now attempts to do more laboriously when hour after tedious hour he collects a small number of recurring themes and categorizes them to see what the patient reveals about himself and the world. However, as Dr. Jaffe puts it, "the computer can furnish a semantic road-map of the patient's sentence structure."

All this is part of a new science called psycho-linguistics—a science calculated to penetrate not only the overt meanings of what a patient says, but also the significance of the form—the sentences and the cadences—in which the patient expresses himself. From these patterns, the psychiatrist can gauge what subjects or events present the patient with the greatest difficulty.

The computer has a memory bank which can store the ten million words a year the analyst hears and then present them in toto for re-examination. For the computer can easily count the number of key words that have been used, thus making it possible for the analyst to examine by electronic means the network of interconnections for further analysis and to ferret out what the words mean.

The new method can reduce the length of the psychoanalytic process and thus make it available to more and more persons. One might add that Dr. Jaffe is heralding a new world in psychoanalysis. As he puts it, "although no sophisticated person today should be impressed by a row of blinking lights, there will come a time when the use of the computer will revolutionize psychoanalysis."

Analytic sessions of the future may be taped and key-punched, with the analyst asking questions, and the computer providing the answers.

Why drop-outs drop out

Why do 50 per cent of all college students in the United States become drop-outs? Hitherto, some have placed the major blame on driving, authoritarian parents.

New evidence presented by the White Institute, however, challenges this myth.

It established a two-year experimental drop-out clinic treating 140 students. The students studied did not drop out because their parents demanded that they equal or excel Daddy's accomplishments. Authoritarian parents, it was found, may saddle their progeny with a lifetime of assorted psychological problems that lead to the psychiatrist's couch but dropping out of college is not one of them. Of the 140 drop-outs, not one came from such a family. Rather, they left college because Daddy had done the same before them.

Their parents never seemed able to complete a course of action. Following suit, they couldn't either; 70 per cent of their parents had either been college drop-outs themselves or had made abrupt career switches.

They themselves had been children who could not say goodbye to Mother at the nursery school door. They were part of a phenomenon that is today so common that many nursery schools have special lounges for mothers to assure proximity to fear-stricken youngsters until the disengagement process is completed. In the case of the college drop-out this process has never been completed but has remained dormant to rise anew. The college drop-out, interestingly, fears separation from parents and home, whether or not the separation involves actual distance. The student at a commuting college seems to fear this separation as much as the one who actually leaves home to live on campus.

These two underlying causes perplexed and plagued the tested drop-outs even though they had the native endowment for academic success. The average I.Q. of the group was 135. All had good high school records and had scored in the 600's to 700's in the College Boards. They were bright, talented and potentially competent.

While on-campus treatment for the drop-out has proved largely unsuccessful, this clinic away from the campus has met with a substantial measure of success. Over half the students it treated returned to school full time after less than a year of therapy. Another third went back to school on a part-time basis.

The hope is that, following the lead of this pioneering clinic, community-treatment clinics for college drop-outs will be established in many cities. That the desire for such clinics exists is evidenced by the fact that, although the number of students treated in the Institute was small, ten times the number asked for help.

Not all drop-outs, however, should be encouraged to return. They may

Children with organic defects or early maternal deprivation, when subjected to environmental stresses, are likely candidates for fire setting.

leave college for good and sufficient reasons. Moreover, not having a college degree is not always a liability. The fathers who quit college seem to have done well enough to give their sons a crack at it. Survey reports show, too, that recent college drop-outs are earning more than their compeers who won their sheepskins. More of the drop-outs, too, are married.

Why children set fires

The injunction: Don't play with fire, assumes macabre meaning when a building in the neighborhood is ablaze and the arsonist turns out to be Johnny who lives next door.

Perhaps Johnny has seemed like a nice boy, but more likely he has given his parents reason to worry about him on many counts long before his attempt at arson.

From Australia comes a study of 21 young arsonists among children referred to the Welfare and Guidance Clinic, or to the Wilson Youth Hospital out-patient department, that relates fire-setting to its psychological roots. This study by Dr. Barry Nurcombe, Medical Director of Youth Welfare and Guidance, Brisbane, Australia, ascribes this antisocial expression of aggression to both the child's immediate and early environment.

Frustration by the environment is the key . . . frustration through (1) outright rejection by parents, (2) the severe denial of attention and affection, (3) premature exposure to adult aggression, (4) inability to achieve scholastically, (5) inability to gain acceptance among children of the same age, (6) the usurpation of parental favor by another member of the family, (7) intense competition for favor within the home, or separation from parents by death or family break-up. Children with organic defects or severe early maternal deprivation, when subjected to these environmental stresses, become the more likely candidates for fire-setting.

The question, however, is why these children choose fire setting as their particular outlet. "One detects in children," says Dr. Nurcombe, "a primitive wonder at a new spectacle and the need to gain mastery of a dangerous thing which has been tabooed. Such chance factors as coincidence of early experience (for example, accidental burning) and emotional traumas may also be significant."

The irony is that a child's natural wonder, distorted by a malign environment, takes this treacherous form. Therapy consists in part of constructively channelizing the sense of wonder.

What fear does to us

Important insight into fear can be gleaned from a study of "Fear and Panic in Nazi Concentration Camps: A Biosocial Evaluation of the Chronic Anxiety Syndrome," by Dr. Edgar C. Trautment of New York City's Lincoln Hospital. Fear in the extremity of the concentration camp highlights how fear functions in general. The conclusion is that severe fear has an inhibiting effect on our mental processes at the same time that it mobilizes our instinctual faculties. This means that when fear is your prevailing emotion, it is a good time to avoid serious decisions or work that calls for rational thought. For at such times, you are more animal than man, reduced to your most primitive, most non-cerebral self.

New approach to stress

Some persons, children as well as adults, develop "immunity to stress." Such persons do not recognize strain. They do not pretend indifference; they have actually acquired it. Emotional pain does not exist for them because they have insulated themselves against it.

These are sick people who are difficult to reach through therapy. Now, however, comes a study entitled "Stress as a Social Problem," by Gisela Konopka, D.S.W., of the School of Social Work, University of Minnesota, and Dr. Jack V. Wallinga, which describes a new approach to these rigid, non-responding, "stress immune" persons.

Abandoning the traditional approach which emphasizes work with anxiety, the authors suggest that treatment should be in three stages: (1) focusing of attention first on healthy aspects of the personality, strengthening these, and avoiding the arousing of anxiety; (2) beginning individual therapy on a supportive level; (3) individual and group treatment, which may now look into the individual's reaction to stress while concurrently making greater demands on him.

The new approach offers new hope for certain persons, especially children, formerly labelled "untreatable."

Thought and the senses

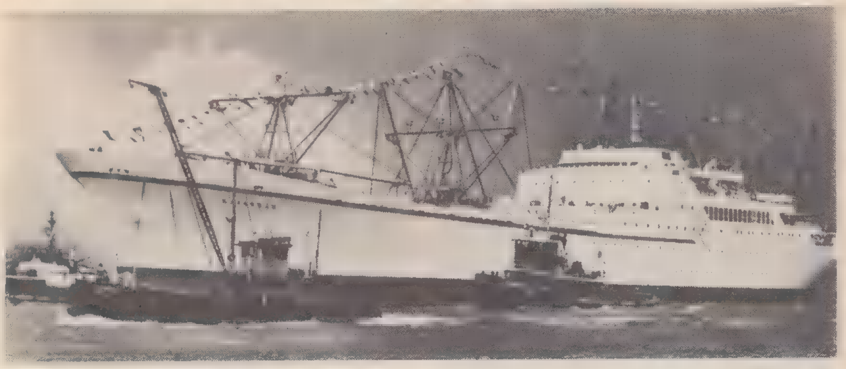
A study by Dr. Eugene Ziskind of the Department of Psychiatry, University of Southern California School of Medicine, Los Angeles, shows that when we are deprived of necessary sensory stimulation we develop mental symptoms.

He opens an important area for investigation by asserting that "the fundamental questions of how and why such deprivation produces mental symptoms have not been answered."

In the absence of the essential answers, however, we can, as individuals, turn to the arts—to music, painting, books and the rest, not only for our pleasure, but also as part of our necessary mental hygiene.

THE BUSINESS STORY

Coming: nuclear ships for profit



Wide World

The world's first nuclear-powered merchant ship, the M.S. Savannah, arrives in New York.

THE USE of nuclear energy to power merchant ships got off to a slow start in the halcyon days of atomic energy. A bold proposal has given it a new lease on life.

The government-supported prototype *Savannah* ran into a pack of troubles, stemming mainly from lethargy, when it first made an appearance. But recently, under operation by American Export Isbrandtsen Lines, Inc., it has been in service carrying freight between the United States and Europe. The operation has been most successful.

Now, American Export has proposed that it underwrite a fleet of four nuclear freighters, which would be the first in the world to have the backing of a private company.

A number of other countries have plans to build atom-powered ships. The proposal to build a fleet, and a private-enterprise one at that, gives the U.S. a new lead where its original one was fast disappearing.

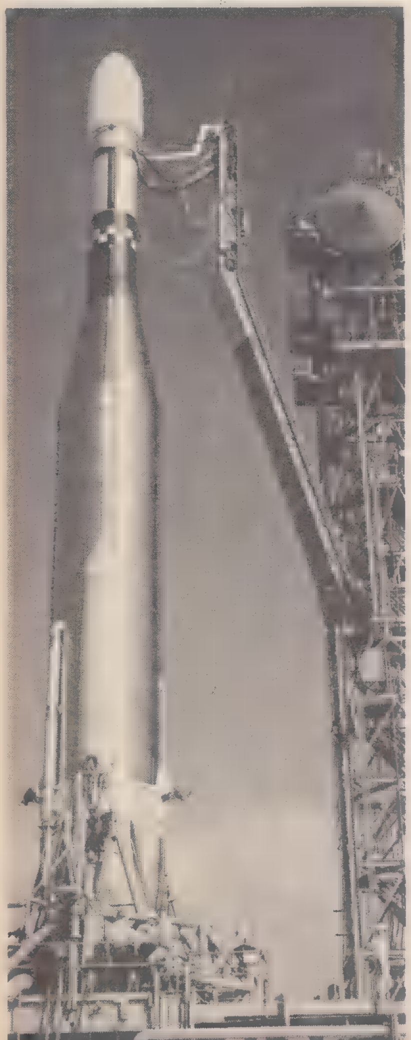
The new ships, if the American Export proposal goes through, will be placed in service between ports on the East coast and the Orient, via the Panama Canal.

No new technical breakthrough is in store. American Export would like to see its proposed new nuclear fleet use the same kind of pressurized water reactor in use in the *Savannah*. That plant is known as the Consolidated Nuclear Steam Generator, made by the Babcock & Wilcox Company.

Cost of the plant is estimated at about $5 million. That's twice the cost of conventional power plants, but the added cost would be overcome by the ships' high speed and savings in fuel costs and weight.

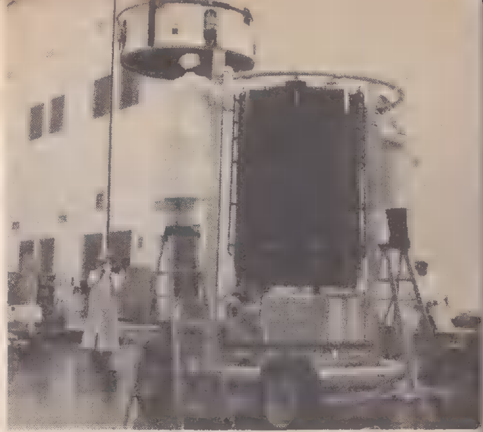
THE SPACE STORY

Rendezvous with



(Left) An Atlas D-Angena D, which is used for the Mariner Mars launches, is checked out at Cape Kennedy. Two Mariners were prepared for 1964 launching.

The shroud for a Mariner Mars '64 spacecraft is lowered into place in one of the "clean rooms." On its way, Mariner drops the shroud and unfolds its solar panels.



NASA Photos

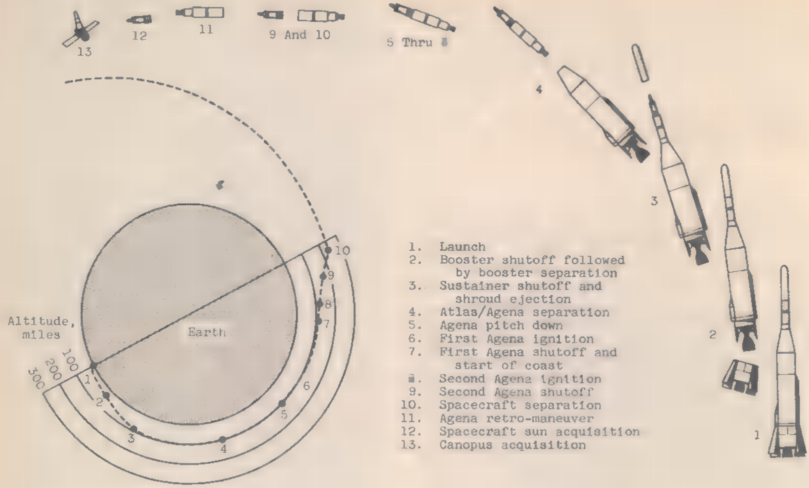
Mars

(Below) Each Mariner craft has four solar panels 71.4 inches long and 35.5 inches wide. The panels contain 28,224 solar cells to convert sunlight into electricity.

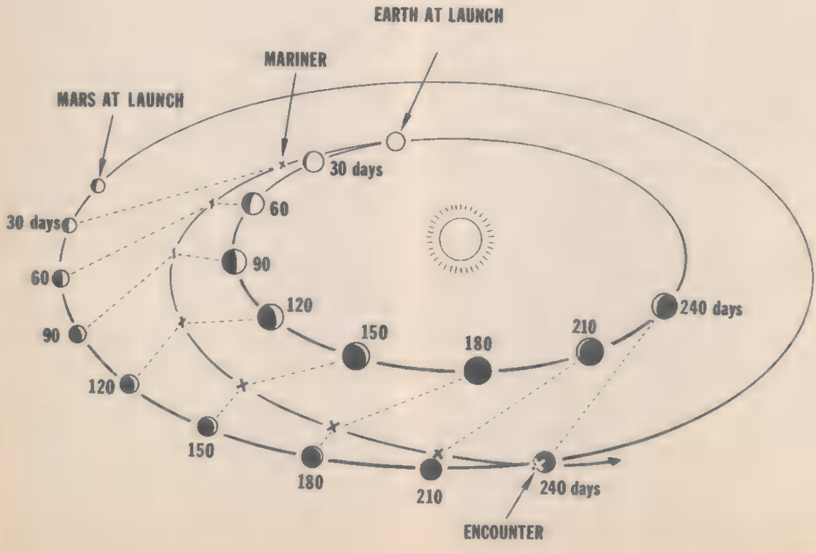
IS THERE life on Mars? Although we know the red planet better than any other in the solar system (aside from our own earth, of course), it still remains a fascinating enigma.

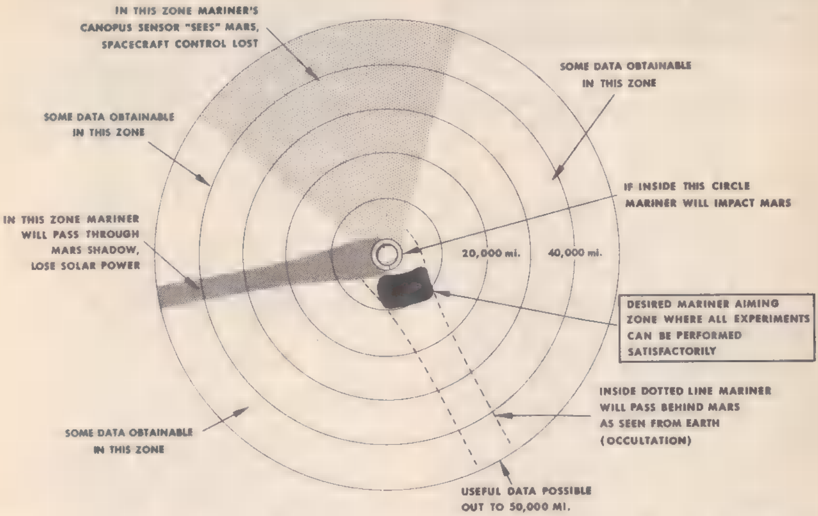
California's Jet Propulsion Laboratory (designer of Ranger 7, the probe that got close-up pictures of the moon) has prepared a series of Mariner probes for an 8½-month, 350 million-mile trip into the vicinity of Mars. If everything goes perfectly, the probes should send back pictures of Mars' surface comparable to those that our best telescopes can take of the surface of the moon. Surface features as small as a mile in diameter could be seen clearly. Such photos should throw revealing light on the so-called canals, the white areas that apparently are the planet's polar caps and the area of possible vegetation that gets darker during the Martian spring.

But Mars will not give up her secrets easily or cheaply (a single Mariner shot costs $37 million). The Mars fly-by is the most difficult spaceshot attempted so far. Communications with the probe will



(Above) A diagram of the initial stages of a typical Mariner launch, showing at what stages the various parts of the booster drop off and where the shroud is ejected. The spacecraft must be oriented toward the sun (12) so that the unfolding solar panels (13) are able to collect the sun's energy in their cells and transform it into electricty. (Below) Diagram of how a typical Mariner spacecraft will overtake Mars after launching.





NASA Diagrams

Once in the vicinity of Mars there are still plenty of things that can go wrong. This diagram shows the small zone Mariner must pass through to give 100 percent performance.

have to be maintained over the 150 million miles that will separate earth and Mars at the time of the encounter. That is almost three times the distance at which contact was finally lost with the Mariner 2 Venus-probe, the present long-distance communications record. Also, the 138,000 components of the Mariner will have to function properly for 6,500 hours in space.

The Soviets are apparently working on a similar Mars shot, although they won't admit it publicly. But the U.S. is ready to try and try again—for a full ten years.

The 10-year attempt to learn more about Mars began in November when Mars and the earth were in "opposition." The orbit of the earth lies inside that of Mars, and hence every two years and 50 days, it overtakes and passes the outer planet. These close approaches are known as oppositions, and all firings must be planned to take place during these favorable periods. Firings are planned for every opposition until 1975.

All the Mariners will not be the same as those launched in 1964. Ultimately it is hoped that a probe carrying life-detection devices can be "soft-landed" on Mars. For of all the planets in our solar system, Mars is the one most capable of supporting some form of life. Recent observations lend support to the theory that there is at least microscopic life on Mars, but the evidence is far from conclusive.

Within the next 10 years, one of the Mariner probes should provide an answer to the question.

Washington: A new science trend

A SHIFT of emphasis in the Government's huge outlay for science is apparent as President Johnson begins a four-year term.

In 1957, when Russia's Sputnik I flashed across the skies, the Government spent just over $3 billion for R&D programs. In the current fiscal year, the figure is near $15 billion.

The sums offer a simple measure of a complex array of Government-sponsored scientific efforts.

To date, space and defense R&D programs have expanded year by year. Now, there's evidence that they have stopped growing.

In a recent survey of the commanding role of government in science, the organ of the American Chemical Society, *Chemical and Engineering News,* declared:

"The Democratic Administration now has turned more attention to long-standing problems of society—poverty, disease, environmental pollution, consumer protection and the like—all of which have large scientific and technical components."

The man who perhaps will have more say than any other, except of course the President, about what research endeavors the Government spends the public funds on is Dr. Donald F. Hornig.

Dr. Hornig is Mr. Johnson's personal science advisor. He also heads the 17-man President's Science Advisory Committee, the Office of Science and Technology in the White House and the Federal Council for Science and Technology, in which representatives of Government agencies coordinate major scientific programs.

Thirteen committees operate under the council, dealing with research in such fields as atmospheric sciences, high energy physics, oceanography, natural resources, behavioral sciences and international programs.

Which fields will be favored, which given fewer funds?

"The thing we are trying to do now," Dr. Hornig told C & EN, "is to weigh the problems field by field: Are there shortages of support and if so of what kind and in what areas?"

A number of studies have been made by the National Academy of Sciences, said Dr. Hornig, and now "a whole string" of new studies is being started by NAS.

Another new Federal trend was indicated in mid-November by Robert L. Sproull, director of the Defense Department's Advanced Research Projects Agency. He suggested a government extension service to channel scientific efforts by universities into enterprises that can't afford basic research.

THE PROGRESS OF MEDICINE

Smoking and cancer: a reverse relationship

by Arthur J. Snider

DOCTORS studying the relationship between smoking and lung cancer in the natives of several Caribbean islands have come up with some astounding findings.

The natives don't smoke cigarettes in the conventional way. They put the lighted end in the mouth and puff. And there hasn't been a case of lung cancer to be found among these natives, even those who have been smoking up to 63 years.

The phenomenon of "reverse smoking" has so intrigued scientific investigators at the Forsyth Dental Center, an affiliate of Harvard Dental School, they have made several trips to the islands to study the natives, mostly women, who traditionally smoke this way.

"It is not inconceivable one day that Americans who can't quit smoking will be urged to do reverse smoking," says Dr. Lawrence F. Quigley, Jr. "It is a simple thing to learn."

Dr. Quigley was first attracted to the Caribbean islands by the absence of tooth defects in the reverse smoking inhabitants, even though their teeth and plates were heavily deposited with tar.

"There may be something in tobacco that interferes with the mechanism by which tooth decay is formed," he says. "If this should be found to be true—and of course, we must check out many factors, including diet—we may recommend that a minimal amount of tobacco be incorporated in toothpaste.

The absence of cancer in the lungs and other vital organs of the body must be analyzed because of environmental and genetic factors known to play a role in cancer development.

"At this stage of our study," Dr. Quigley says, "the work raises some questions about the postulated relationship between tobacco and lung cancer.

"It may offer some support for the viral theory of cancer. The heat of the cigarette inside the mouth—1400 to 1600° F., or about the temperature of a glowing coal in a coal stove—may destroy the viruses present in the tobacco or in the cigarette paper."

Although the origin is not known, the custom of reverse smoking is probably centuries old. The modern concept of cut tobacco placed in a thin container of paper probably was beyond the skill of the first people who smoked tobacco. It was easier to take a tobacco leaf, roll it, light it and place it inside the mouth.

On questioning Caribbean women on why they smoke this way, Dr. Quigley found they prefer it in performing their household duties. It keeps ashes from falling in their food or on clothing.

In strong trade winds of the Caribbean, reverse smoking also extends the burning time of a cigarette from two minutes to as long as 18 minutes and prevents ashes from being blown about.

Smoke is inhaled little, if at all. Instead the smoke and tar products are allowed to condense on the surface of the teeth and palate. Air is supplied to the burning zone through the unlighted end and smoke is expelled back through the cigarette itself or through the mouth.

Children warned on isometric exercises

Isometric exercises offer a rapid method of putting mature football players in condition and for business men on a tight schedule, but they should not be used by children.

Dr. Nick J. Accardo, a New Orleans surgeon and a former football player says youngsters can be injured because their muscles are more advanced in growth than their bones. Isometric exercises are those involving exerting maximum effort against an immovable object. They may be as simple as merely interlocking the fingers of the two hands and pulling hard in opposite directions.

While this may develop shoulder muscles in adults it can lead to a dislocation of the shoulder in still-developing youngsters, Dr. Accardo says.

75 viruses cause common cold

In the winter season now upon us, you can be hit with at least 75 viruses known to cause the common cold. Some of these have been incorporated into vaccines which offer a measure of protection, says Dr. Robert M. Chanock, chief of the respiratory unit of the National Institute of Allergy and Infectious Diseases.

Ready for human trial is a new experimental vaccine against the respiratory syncytial virus (RSV), which is especially dangerous to infants. Promising preliminary results have been achieved with a new vaccine against some of the so-called adenoviruses which have created upper respiratory outbreaks.

While influenza vaccines have been available for some time, several new ones are undergoing preliminary testing.

Dr. Chanock says colds and related ills occur at the rate of 227 million cases yearly in the United States and costs one billion dollars annually in medical bills.

Surgery lowers cholesterol level

The newest attempt to lower the cholesterol level of blood is a short-circuiting operation that takes seven feet of the 20-foot coil of small intestines out of action. Of the first nine patients who have undergone the operation at the University of Minnesota, eight have experienced a marked reduction of cholesterol. The ninth died just as he was about to be discharged from the hospital.

Dr. Henry Buchwald, who with Dr. Richard Varco developed the surgical approach, declines to draw any long-range interpretation from the work. "All we can say now is that we have reduced cholesterol values of patients by an average of 40 percent beyond what could be previously achieved by diet alone," he comments. "Whether this is significant depends on whether you believe in the cholesterol theory of heart disease."

Cholesterol is a chemical component of animal oils and fats. Excessive amounts are deposited on blood vessel walls in some individuals. There is a difference of opinion among some medical men as to the role of cholesterol in developing coronary artery disease, particularly whether attempting to lower the level in the blood is beneficial.

Theory behind the Buchwald innovation is to interrupt the continuing cycle by which the body absorbs and reabsorbs into the blood the cholesterol that it manufactures itself as well as the cholesterol taken in by way of diet.

The by-pass operation tricks the body into eliminating a portion of the cholesterol through the stool. In order to make hormones, which are dependent on cholesterol as a raw material, the body would theoretically draw upon the cholesterol in the blood vessels.

Patients who prior to surgery had seriously elevated cholesterol levels in the 300 mg. percent range now have values of about 200 mg. percent, which is the general average.

It has been found that maximum reabsorption of cholesterol occurs in the lower third of the small intestines, a sector known as the ileum.

Of Buchwald's nine patients, five had at least one heart attack before surgery. Seven had angina and two had no symptoms except for an elevated cholesterol level.

The latter two were sisters, ages

28 and 22, members of a family in which brothers and sisters had died prematurely of heart disease. Their own life expectancy had been 25.

Another patient, a 36-year old father of several children, had suffered three heart attacks. A stringent diet brought his cholesterol level down from 330 to 250. After surgery was performed, he was listed at the 150 level.

No weight is lost since the patients are able to eat cholesterol foods and fats without restriction.

"Tricks" that can save lives

Surgeons call them "trick" operations but the procedures are not in the nature of a prank. They are ingenious devices to overcome a dangerous medical abnormality.

One is an auxiliary pump implanted in the body to help the tired, failing heart. The other is a "clothespin clamp" that fits across a blood vessel to compress and narrow its channel so that lethal clots can't get through.

The heart pump, applied only to dogs thus far, is a bulb-shaped contrivance that has succeeded in reducing the heart's work load by about 50 percent. It is placed across the arch of the aorta, the body's main blood trunk line. Blood leaving the heart is shunted through the pump whose squeezing action impels the flow upward into the brain and downward through the body organs.

The pump works in tandem with the heart's natural pumping action.

Dr. Yukihiko Nose of the Cleveland (Ohio) Clinic, who developed the pump with Dr. Adrian Kantrowitz of the State University of New York Downstate Medical Center, Brooklyn, says a small-battery powered motor, weighing three pounds and about the size of a package of cigarettes, supplies the energy for the pump. The motor, worn by a dog on its harness, has been able to drive the pump for about 10 hours without recharging.

Efforts now are being directed toward developing a permanently implantable pump that can be used in treating myocardial (heart muscle) insufficiency.

The "clothespin clip" was fabricated to prevent clots that form in the lower limbs and break off to travel up the blood vessels to the lungs, brain or heart often with fatal results.

Burn accidents: an unrecognized menace

The number of burn accidents is becoming catastrophic. Since World War II, more than 30 million people have received burns serious enough to require medical treatment or cause them to be work-incapacitated. Of these, more than 1,250,000 have been hospitalized.

Half the burns occur in the home, caused by inflammable clothing igniting from gas stoves and other open fires, by use of gasoline to clean clothes or scrub wax off floors, through carelessness with matches, through scalds and grease burns in the kitchen, by handling lye and

acids, and by defective wiring.

Dr. Truman G. Blocker, Jr., of Galveston, Tex., said that while the world lives in fear of the burn casualties that would result from atomic warfare, people seldom realize that burns are occurring every day in catastrophic numbers.

While the vast majority of burns are accidental, sometimes they result from a conscious or unconscious suicide attempt. Four patients recently poured gasoline over their clothing and set fire to themselves, apparently under influence of newspaper reports of Buddhist monks who have burned to death in protest demonstrations in Saigon, Dr. Blocker says.

Treating burns can be long and costly. One patient has had 27 hospital admissions and a total of 63 separate operations for scars. Where the usual hospital stay of the average patient is 6 to 15 days, the burn patient requires at least three weeks to prepare for a graft, an additional 12 to 14 days between grafts and finally two or more weeks before discharge.

Leukemia virus theory

The virus that theoretically has caused a case of leukemia today may have caused a tumor or leukemia in a distant ancestor. It could have passed without causing any harm through a great grandfather, then through the grandfather and through a father before striking again.

Accordingly, one century or even two might conceivably elapse between successive cases of cancer or leukemia due to the same agent, and transmitted from one generation to another, says Dr. James P. Cooney, vice president for medical affairs of the American Cancer society.

Proving or disproving the idea is difficult, if at all possible. One reason is that after a virus invades a cell, possibly triggering a cancer-producing change, the virus can not be detected by any known method.

New medical use for lasers

In biology, lasers have been used to repair detached retinas of the eye and to destroy malignant tumors. A new use has been developed at Montifiore Hospital, New York. Dr. William Z. Yahr has used the laser beam to join small arteries in animals. He says it is superior to surgery which requires a steady, dry field and a long period of blocking the flow of blood to accomplish the union. Mechanical staplers have been used, particularly in Russia, to unite blood vessels but these, too, have not eliminated the necessity for interrupting blood flow.

REPORT OF THE MONTH

How to dress warmly in winter

by **Bruce H. Frisch**

MOST of us are going to shiver our way through this winter simply because we are slaves to style. Take the man waiting for a bus in some city in the northeastern U. S. He is in what Dr. Paul Siple, the Army's chief expert on clothing, calls a three-layer climate. He is wearing a suit, overcoat, scarf, dress gloves and galoshes, and he's cold. Why? According to Dr. Harwood Belding, Professor of Environmental Physiology at the U. of Pittsburgh, he has the equivalent of only two layers around his trunk and arms, one layer for his feet, and one-half layer on his hands.

Going into World War II, the Army uniform was almost as casual and style-conscious. The threat of a war in Alaska and the sight of the German army frozen in its tracks by a Russian winter sent the military into action. The Army Air Corps called on the Arctic explorer, Vilhjalmur Stefansson, to write an *Arctic Manual.* In it he described the Eskimo costume as the best in the world. It may still be.

Next to his skin the Eskimo wears newborn caribou fur, with the hair side in. Over this he wears a second heavier layer, hair side out. Even today this outfit is lighter than the Army Arctic assembly. But the government couldn't count on Eskimo women to chew enough caribou skins for an army (chewing makes the skins flexible enough to wear), so it began investigating cold weather clothing scientifically. The Army Quartermaster Corps first set up shop in a cold chamber that Pacific Woolen Mills of Lawrence, Mass., had built to freeze grease out of wool.

One of the first findings was that there was nothing special about caribou as an insulator and that cotton was about as good as mink. Most furs and other insulators give about four clos of insulation per inch of thickness. One clo is the amount of insulation needed to make a man comfortable in a 70° F room. It is equivalent to a business suit outfit, a one-quarter inch thickness of clothing, or one of Dr. Siple's layers.

All of the insulating value comes from dead air. Air alone is worth seven clos per inch, but the fabric or hairs to keep it trapped reduces the effectiveness. Trapped air is most effective in quarter inch slices. If a loose fitting outer garment traps a quarter inch of air between itself and the undergarment, it contributes a quarter inch of free insulation. From this discovery grew the

The Army's experimental Thermalibrium suit wraps the soldier in his own tailor-made environment. He is bathed in filtered air which is cooled in the summer, heated in the winter. Model aircraft engine, fuel cells are possible sources of portable power.

Rain is a problem. It soaks clothing, fills dead air spaces and destroys their effectiveness as insulation. Shoes are especially vulnerable.

Army's "layer system" of many light, loose garments rather than a few heavy ones.

It also led to breaking down the U. S. (and the rest of the world) into layer zones. The two-layer zone, requiring a one-half inch thickness of clothing, covers the southeastern United States between the Gulf and the Ohio River and the Pacific coast in the Northwest. Winter temperatures normally run 32° to 50° F, so precipitation falls as rain.

But rain is a problem, it soaks into clothing, filling up dead air spaces and destroying their effectiveness as insulation. Shoes are particularly vulnerable, especially because a person is usually able to get less insulation around his feet—and his hands—than around the rest of his body. At these moderate temperatures, the feet may not get cold enough to warn a person before he gets an itching, burning, swollen case of trench foot or chilblains.

Rubber boots and ponchos keep out the rain but keep in the sweat, with the same consequences. Siple and Dr. H. C. Bazett hit upon the idea of sealing insulation in rubber so it couldn't be wet from the inside or outside. The new boots reached the Army in Korea in the winter of 1952-53 and almost eliminated cold injury to feet. A little later, the Quartermaster Corps concocted a chemical water repellent named Quarpel that stands up to repeated launderings. Treated cloth keeps out most water, but lets body vapors escape.

Although most everyone will agree that it feels colder when it's damp, Dr. Douglas Lee of the U. S. Public Health Service, says, "Experiments have failed to reveal any solid proof of this unless the clothing is actually wet."

The three-layer zone covers the northeastern United States north of the Ohio River, and the high mountains of the West. Winter temperatures are generally between 14° F and 32° F. Wind can make it feel much colder. In a two-to three-mile-an-hour wind, the skin cools at twice the rate it does in air moving at under one mile per hour. Thus a thin windbreaker can do as much to keep you warm as a much thicker layer of insulation. Measured in subjective terms, a lightly (and inadequately) clad man standing in still air at about 23° F will feel cool. (Bright sunshine will make him feel pleasant, even at this temperature.) When the wind reaches one to two mph, he will feel cold; at about four mph, very cold; and at about nine mph, bitterly cold. Expressed in still another way, a rise in wind velocity from zero to four mph has about the same cooling effect as a ten-degree drop in the

temperature of still air. This "wind-chill" effect is greatest at low wind speeds when one is wearing little or no clothing, because it works by breaking up the stagnant air layer over the skin or clothing.

The four-layer zone, with a sub-arctic winter, takes in Montana, North Dakota, Wisconsin and Maine. Temperatures run from zero to 14° F. At the end of World War II, this was the limit of Army equipment. No non-Eskimo clothing was adequate by itself for the Arctic winter. It simply takes unmanageable thicknesses of insulation to protect an immobile man. An Army sleeping bag for -40° F has the equivalent of 10 to 11 layers of down and would still let a man freeze to death if he stayed in it too long. At 0° F a sitting man requires over seven layers. On the other hand, a man dressed in only two layers and walking briskly carrying a 45-pound load can take a -60° freeze. That is why the Arctic winter zone is also called the controlled activity zone. A man there has to keep on the move, gauging his exertion according to the weather.

Sitting, a man throws off about the same amount of heat as a 75-watt light bulb. This is called one metabolic unit, or Met. At a desk or in a car, a man produces 1.6 Mets. Doing light work at a machine, he generates two Mets. At a brisk walk, four Mets, and at a brisk walk with a 45-pound pack, six Mets. The most violent shivering produces three Mets and allows a naked man to survive at 36° F.

The Athabascan Indians of Canada, who live south of the Eskimos, depend heavily on exercise for survival. Their climate is just as severe as the Eskimos', but they have never developed adequate clothing and shelter. Outdoors during the day, they never stop moving and while they sleep they constantly shiver.

But exercise is easy to overdo.

How to keep warm in style

These six suggestions will help you make the best of the inadequate winter fashions:

1. *Wear a hat.* Your head is the biggest heat leak in your body.
2. *Keep on the move.* You produce four times as much heat walking briskly as you do sitting.
3. *But don't get overheated.* Unzip or undress first, or you'll get chilled when you stop. Sweat-soaked clothes also insulate less.
4. *Get "free" insulation* from dead air trapped between an extra light, thin layer or two of clothing.
5. *Close openings* around ankles, wrists and neck. Wind blows in; warm air escapes out.
6. *Protect your most vulnerable spots*—your face, feet and hands. They are the most exposed parts, so get coldest. Discomfort to them can drive you indoors, although the rest of your body is warm.

The biggest heat leak in the whole body is through the top of the head. At 40° below, it dissipates all the heat an inactive man produces.

Sweat soaks into clothes. After work has stopped and the need for cooling has ended, the sweat continues to evaporate and produces a chill. In the extreme cold, sweat and "insensible perspiration," which rises as a vapor from dry skin, freezes into powdery hoarfrost in the clothing. As the day warms up or if a man goes inside, the frost melts, then turns to ice when he goes outside again. After a few such cycles, the clothing is weighted down with ice and has lost its insulation value.

The smart man never lets himself get overheated. In a series of graded steps he pushes back his hood, bares his knees, takes off his mittens and finally starts unzipping layers or taking them off. The novice takes off clothes too late and leaves them off too long.

The biggest heat leak in the whole body is through the head. To conserve heat, a cold body cuts back blood flow to the skin, the feet and hands. It never shuts off blood to the head. At room temperature, up to 25 percent of the heat leaving the body goes out through the head. At 40° below, the head alone can lose all the heat an inactive man produces. More goes out through the back and top of the head just where a hat should be.

A big advantage of the Army layer system is that insulation can be peeled off bit by bit. The World War II uniform also turned out to have self-regulation inadvertently built in. When Belding tested the outfit, he found that it was only half as effective when a soldier was on the move. Bellows action was squeezing stagnant air from between the layers of clothing. This could help keep a soldier from overheating, but could also make him cold. More attention was paid to closing openings at the ankles, wrists and neck. When he needs to, the soldier can open the waist and neck, creating a chimney-like draft up under his clothes.

Norwegian string vest

A Norwegian string vest makes this maneuver work even better. It is made of a heavy yarn fashioned into an open mesh with holes about one-half inch across. Worn next to the skin, it creates a thick, dead air space when the neck and waist are closed. When the waist and neck are open, the holes admit cool air to the skin. Sweat evaporates directly to the air for its full cooling effect.

The scientific approach to cold weather clothing had made tremendous strides by the end of the Korean war, but two problems remained—weight and cold hands.

The Army used wool for insulation under a windproof cover. It made a comparatively light uniform

and could take up a lot of water before starting to lose its insulating value.

The crinkly fibers in wool pushed out in all directions to give it its low density. These hairs touched the skin or the next layer of fabric over only a small area and thus conducted less heat from the body. At the fabric surface, the hairs matted together to form the outer shell of a sort of fiber sandwich.

In recent years, manufacturers have duplicated this sandwich with acetate or polyester fiber, or polyurethane foam between shells of Dacron, nylon or rayon. Eider down is still the best and most expensive filler. The Army dry cold outfit has two liners of polyester between nylon and still weighs about 26 pounds without the helmet.

The one cold-weather clothing problem that has almost completely resisted science is cold hands. The basic difficulty is that we may put inches of insulation around our torsos but only a token amount around our hands. Yet if we put more than about a quarter inch of insulation around the fingers they become almost useless. In addition, insulation around the fingers is inefficient. The fingers are shaped like small cylinders. They have a large surface area that releases much heat for their small volume. More than one-quarter inch of insulation is almost useless. The additional layers add practically enough surface area to cancel out their insulating value. Except in the wind, thin gloves can actually be colder than no gloves.

To protect soldiers from atomic, biological and chemical warfare, the Army wants to develop a suit that is heated and air conditioned.

Mittens combine the fingers into a larger volume that can use insulation more efficiently. A new trick the Army is trying is to put a thicker layer of insulation over the back of the hand where the large blood vessels are and less over the palm for easier gripping.

Most ordinary gloves and mittens are cut to lie flat. When you flex your hand the insulation is pulled tight and thin across the back of the hand. As the thickness is reduced, so is the insulation. In the same way, cold spots form when you lean on an elbow or sit. A glove or mitten cut to fit a naturally curved hand maintains the full thickness of insulation.

Gloves and mittens

What the modern Army needed as much as warmth was a glove or mitten that would let a technician make delicate adjustments to electronic gear.

Past approaches along these lines had included a three-finger mitten and also a three-finger mitten with room inside for the index or trigger finger to be withdrawn for rewarming. While in the Antarctic, Siple had sometimes put his hands inside a down pillow. The thick puff of feathers easily compressed to a thin layer when he grasped something. But how would he pick up a penny? With plastic fingernails. The Army has put them on experimental artificial fingers which are outside the mitten but manipulated from inside.

Work on heated gloves never really stopped from the days of the electrically heated flying suits of World War II. At that time, the Army Air Forces (now the Air Force) found that crew members fell asleep when their hands, feet and body were heated. If their hands and feet were unheated and got cold, they stayed alert.

Ventilated suit

Later research showed that to keep the hands and feet warm, the whole body had to be kept warm. The Air Force could easily do this by plugging ground mechanics into portable generators and pilots into the aircraft electrical system. The Air Force also tried blowing hot air through a ventilated suit.

The Army tried to make do by periodically rewarming the men. Heavy clothing, however, turned out to be as good at keeping heat out as it was in keeping it in. Rewarming was done by body heat itself and was quite slow. The quickest way of reheating proved to be violent exercise.

The Quartermaster Corps looked into several portable suits heated by a steam boiler, gas turbine or bottled gas burner.

All these suits were too heavy. Although heating the whole body was theoretically best, it took too much power, which meant too much weight. The Army went back to the idea of heating only the hands and feet to extend tolerance time in the cold rather than make it indefinite. Even when the rest of the body is warm, discomfort to the most exposed parts often limits the time outdoors.

The Quartermaster Corps came up with a compact seven-pound vest holding about 11 silver-cadmium batteries to power electrically heated gloves and boots.

Working from a different direction, the Ethyl Corp. is building chemical heaters into a survival suit for the Navy. Sea water reacts with sodium aluminum hydroxide to produce hydrogen. The expanding gas drives a fan which sends air to various points in the suit where it burns the hydrogen catalytically. Dr. E. B. Rifkin, who heads Ethyl's Detroit labs, says that a suit for a land-bound man could run on the moisture in his breath.

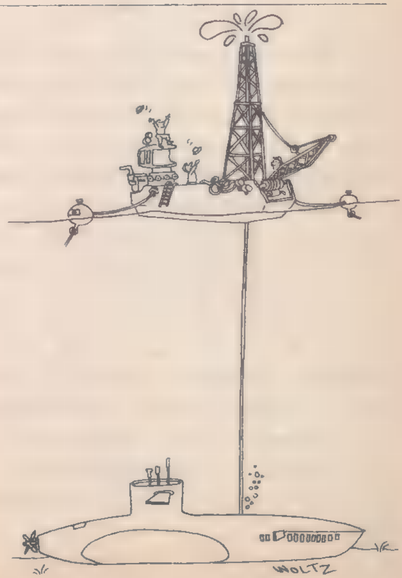
The Army has even bigger ambitions for the future. To protect soldiers from atomic, biological and chemical warfare, it wants to develop a suit that would be both heated and air conditioned. This one "thermalibrium" outfit, weighing about 20 to 26 pounds (civilian version could be appreciably lighter), would keep a soldier comfortable in temperatures 40° below to 110° above.

A space-type helmet with a built-in two-way radio would fasten to the top.

In one possible scheme, there would be separate heating and cooling systems. An absorption, or gas, refrigerator with blowers powered by a steam engine would provide cooling; a gas burner with a battery-driven blower might supply heat.

An alternative system would combine both heating and cooling in one heat pump. It would be driven by a model airplane engine. When cooling, it would refrigerate air going into the suit and dump the heat outside. When heating, it would refrigerate air warmed by the engine and dump the heat inside the suit.

Soldiers may welcome such an all-weather personal and perfect climate, but we civilians will probably insist on two-button styling and snap-brim helmets before giving up our frozen elegance.



PERSONALITY OF THE MONTH

Park-bench scientist . . . but

Charles Hard Townes

If he had known, the American sports fan watching the 1964 Olympics live on TV would probably have raised his beer glass to physicist Charles Hard Townes, the man to whom he owed it all. It is Townes's invention, the maser, that amplifies the weak signal from Telstar by 10,000 or more times.

On Dec. 10, in Oslo, Norway, for his work on the maser and laser, Professor Townes received $26,500, his half of the Nobel Prize in Physics. The other half went to Professors Nikolai Basov and Aleksandr Prokhorov, of the Lebedev Institute for Physics in Moscow, who built an ammonia gas maser at about the same time as Townes.

The story goes that the basic idea leading to the maser and laser popped into Towne's head early one spring morning in 1951, while he was sitting on a bench in Washington's Franklin Park admiring the azaleas.

It is a misleading story, because Townes had been building up to that inspiration all his life. By the age of 19, he had zipped through Furman U. in Greenville, S. C., his hometown, with two degrees. One degree was in physics, the other in modern languages. He chose to follow physics, getting a master's degree at Duke and a doctorate at Cal Tech.

In 1939, he started to work at Bell Telephone Laboratories, just in time to take part in the development of a radar bombsight. At this time scientists were using the high-frequency radio waves made available by radar research to excite gas molecules as a way of studying their structure. After the war, Townes turned to this new science, called microwave spectroscopy.

Eventually microwave scientists hit a ceiling; vacuum tubes couldn't produce higher frequencies. When

Townes sat down on that park bench, he was trying to crack this problem. By that time, he had been working with high-frequency radio waves for a dozen years. He was ready. He asked himself, he recalls, "Why not use molecules and atoms to amplify radio waves?" It would be almost the opposite of microwave spectroscopy. Instead of putting energy at a certain frequency into atoms, one would take it out, and at higher radio frequencies than had ever been generated.

"Many people told me the idea wouldn't work, but I went ahead anyway with some associates willing to take the risk," Dr. Townes says. He was then on the faculty at Columbia U. It took him three years to make the first maser work.

In 1958, he joined with his brother-in-law, Dr. Arthur L. Schawlow of Bell Labs, to open up an even bigger field. Together they devised and patented a way to push the frequency of the maser still higher, into the infrared and visible portions of the electromagnetic spectrum. This new version they called an optical maser or laser. Dr. Theodore H. Maiman of Hughes Aircraft built the first one in 1960.

The nucleus of an atom is ringed with electrons whirling in orbit. An electron in an outer orbit has a specific amount more energy than one in an inner orbit. To jump to the outer orbit, the inner electron must first absorb the extra energy. If it returns to the inner orbit, it gives up the package of energy by radiating it away.

In the original laser, a photographer's electronic flash tube surrounded a thin rod of synthetic ruby. The ruby contained a trace of chromium, the active atom in this case. The flash tube supplied the energy to pump electrons into an outer orbit. A few of the electrons spontaneously returned to the inner orbit, radiating red light. Silvered ends on the ruby kept some of the light bouncing back and forth, triggering more electrons into a return jump. The energy released fell right into step with the triggering wave. Part of it escaped out one end that was only partially silvered.

The beam is narrow and intense and spreads very little. Every wave is the same frequency and right in step like a radio beam. Most of the proposed uses depend upon its power to burn, cut or weld; act as an extremely accurate radar, or carry communications. It is estimated that a single laser beam could carry all the radio, telephone, teletype and TV in the world.

Dr. Townes says, "I like to experiment in different directions." He tries mountain climbing, skin diving and collecting African violets in his spare time. Professionally, this desire led him to step out of the lab to direct the research and teaching program of the Massachusetts Institute of Technology. At the same time, he is working on a phonon maser which has produced sound waves with frequencies of up to six billion cycles per second.

As a friend says, "Charlie does everything."

TIPS AND TRENDS

SCIENCE IN INDUSTRY. The Xerox Corporation is depending on research to keep its big lead in the copying field. Its new 106,000-square-foot laboratory building helps accommodate a scientific staff of 1,200 whose goal is a wide variety of innovations in visual communication. In view: instantaneous xerographic computer read-outs using electronically formed letters and figures; copies of books from microfilm (copyright law violators, beware); medical and legal information retrieval depots able to deliver copies of data required by telephone.

MORE HURRICANES FOR FLORIDA. Weather experts believe the high incidence of hurricanes in Florida this past season may continue for some years. Sunspot activity is thought to have shifted the pattern of Atlantic winds that keep hurricanes at sea.

PICTURE OF THE WORLD. What does the earth look like as seen from space? NASA photographic experts have made mosaics of continents, hope soon to piece together a picture of the entire world as seen by Nimbus (weather satellite) before it went dead.

PHYSICS, ANYONE? Scientists and high-school teachers hope to check the continuing drop in the proportion of students who take physics in high school. A group of them have formed Harvard Project Physics to develop a new course. It attempts to treat physics as a lively science that is also closely related to achievements in other fields.

THE BIOLOGY STORY

Again, Lysenko

KFS

Trofim D. Lysenko

The career of Soviet biologist Trofim Lysenko ebbs and flows with the tide of Soviet politics.

Today Nikita Khrushchev is out, and Lysenko has been submerged with him. Russian political leaders rarely have a chance to make a comeback, but the 66-year-old Lysenko has been out of favor before, and there can be no assurance that he, and his curious evolutionary theories, will not again dominate Russian biology.

The Russians have produced leaders in practically every field of science—except biology. The reason: the power of Lysenko.

Lysenko's theories were derived from the teachings of Ivan V. Michurin, a Russian biologist who believed that an organism can transmit to the next generation characteristics acquired during its lifetime.

He disregarded recent discoveries in molecular biology, and tried to discredit research in DNA and to prevent new biological findings from being taught in Soviet schools.

Classical Mendelian genetics, the theory favored by most of the world's biologists, including many in Russia itself, holds that new hereditary characteristics are introduced only by mutations of genes and chromosomes.

The Lysenko school became official under Stalin in 1948. The theory appealed to Stalin for two reasons. First, the idea that hereditary characteristics could be altered by environment fitted neatly into revolutionary Marxism. Second, the thought that Lysenko and his teacher Michurin, both Russians, could overturn Western genetics appealed to Stalin's nationalism.

For years, Russian classical geneticists had to keep very, very quiet. In the period of relatively free scientific discussion that followed Stalin's death, Lysenko lost ground. By 1956 he was removed from the presidency of the Soviet Academy of Agricultural Sciences.

But as Khrushchev rose to supreme power, he towed Lysenko along with him. Khrushchev was a

practical man, less interested in Marxism and nationalism than Stalin, but he was beset with crushing agricultural problems. Whatever else might be said against Lysenko, he was a successful plant and animal breeder. He promised, and produced, some superior strains of plants, and better milk cows.

By 1961, Lysenko was again president of the agricultural academy. The following year, one of his strongest followers, Prof. Mikhail Olshansky, took over the job.

In the fall of 1964, Lysenko was reaching new heights. Khrushchev himself specifically defended the Michurin school of biology. As late as Aug. 29, Prof. Olshansky was able to verbally flay Lysenko's opponents in an article in the agricultural newspaper *Selskaya Zhizn*.

He chided them for not having developed one good new agricultural crop with all their theories.

On Oct. 2, the Botanical Institute of the Academy of Sciences was criticized in *Selskaya Zhizn* for its anti-Lysenko attitude.

But by Oct. 22, just a week after Khrushchev's abrupt removal, *Selskaya Zhizn* was giving the other side of the story. A long article on genetics signed by I. Rapoport dealt with chemically induced mutations, a theory that Lysenko rejects.

The article also praised the work of some of Lysenko's past opponents, including Nikolai I. Vavilov, who was replaced by Lysenko as director of the Institute of Genetics in 1940 and died in a labor camp.

In the article, Lysenko's work was pointedly ignored.

The following day, a major article in the paper *Komsomolskaya Pravda* was devoted to praising the work of a woman scientist whose work, based on classical genetics, had been suppressed by a follower of Lysenko.

The tempo of criticism was stepped up and by mid-November *Komsomolskaya Pravda* could rebuke Lysenko by name for having insulted prominent Soviet scientists in his journal *Agrobiology*.

Nikolai P. Dubinin, a scientist who had lost his genetic research post in 1948 when Lysenko was the virtual dictator of Soviet biology criticized Lysenko on the radio, and *Izvestia* printed the criticisms of another Soviet biologist, who said that the study of genetics had been "held back by the dogmatic views of some scholars."

The New York Times seemed almost as delighted about Lysenko's fall as were his scientific opponents. A Nov. 12 editorial stated,

"Aside from former Premier Khrushchev and his son-in-law, Aleksei Adzhubei, the most prominent casualty of last month's Moscow political changes appears to be Trofim D. Lysenko, the biologist whom many Western scientists consider to be a charlatan."

Significantly, one of the major charges leveled against Khrushchev by his successors was his "refusal to take into account scientific findings."

The next question: Will their politics allow them to?

Our next

by Earl Ubell, David Hoffman and Joseph R. Hixson

WITHIN the next three months, Astronauts Virgil I. ("Gus") Grissom and his co-pilot John Young will be rocketed into space in a single space capsule. This will open the second phase of America's race to the moon.

The Soviets began an advanced phase of their side of the moon race in October, when they orbited three men in a single capsule.

Starting with the Grissom-Young trip, a 500,000-pound-thrust Titan II with two men perched on top will jump off Cape Kennedy every three months until 1967. In these flights, the men will carry out one spectacular after another, including staying in orbit for two weeks.

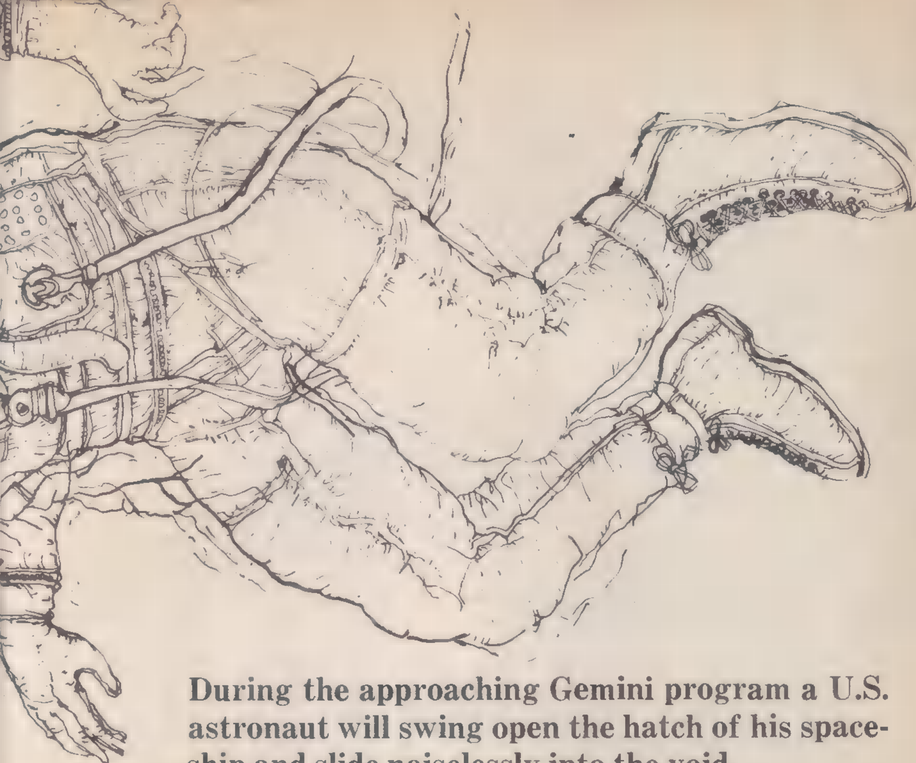
But the most impressive event in the program will take place near the end when an American astronaut will swing open the hatch of his space ship and slide noiselessly into the void. In his gleaming suit, he will look like a giant silver insect—wings torn off, a thread attached to his chest.

Outside his cocoon, the space vacuum can tear him apart like an over-blown balloon. There the sun-fire radiation can fry him. Without air-conditioning in his suit, the weird space "weather" could freeze him solid or boil him alive.

And should that tether snap, he could float in orbit like a particle of nameless dust until—perhaps centuries later—chance encounters with air molecules and dust slow him down to re-enter the atmosphere at 17,000 miles an hour, vaporizing him in the white heat of slowdown.

Yet to the men planning to take the journey into space, the prospect of danger seems no more disturbing than a walk to the corner drug store. Indeed, the first step of that voyage—testing the space craft in orbit—seems old hat for its commander.

"I feel as though I'm living my life over again," Astronaut Grissom says. The astronaut was the



During the approaching Gemini program a U.S. astronaut will swing open the hatch of his spaceship and slide noiselessly into the void.

adventure in space

second American to ride a Mercury capsule aboard a rocket (he never entered orbit; his was an up and down hop).

The project will cost—according to current estimates—$1.3 billion. It will engage the attention of 2,000 to 3,000 engineers and technicians. It will take 12 Titan II rockets that might be used for military weapons (at a cost of $300 million). To what end? Just to present a super-space show to the world's nations?

The men at the Manned Spacecraft Center at Houston, Tex., who created Project Gemini say no—they have their eyes on the moon. They want to carry out President Kennedy's charge to land a man on the lunar surface before the end of the decade in the $30 billion Project Apollo. And to get to the moon, the engineers say they need Gemini.

The tasks ahead in Apollo are so huge, almost so hopeless to conceive, that the engineers and astronauts want more space practice. In Apollo, the technicians must launch a giant 7.5-million pound thrust rocket on schedule. They must operate a space ship that comes apart and joins together in space. They must leave their ship and face the

The NASA crew and back-up crew selected for the coming Gemini two-man flight, stand alongside the Titan II booster that was selected to place them in orbit.

void. In leaving the moon, they must fire one rocket from the surface to join another capsule circling overhead. And altogether they must learn to live for at least seven days in space.

So the Gemini program was conceived to give the astronauts and engineers practice between the last of the Mercury flights and the first Apollo missions, scheduled for 1966 at the earliest. Those early Apollo trips would not go to the moon, they would merely circle the earth as Gemini will.

Specifically everyone wants to know the problems of pulling two space ships close to each other in orbit and locking them together—rendezvous and docking. In Gemini, they will launch an Atlas with an Agena D rocket aboard. The Agena will go into orbit. The next day the Gemini will soar aloft and attempt to catch the Agena.

Two rockets

To carry out this mission, the two rockets must leave the ground exactly 24 hours apart. The groundsmen will have to prepare two rockets at the same time: simultaneous countdown. They will have to launch the second within 12 minutes of that 24-hour deadline. Under certain circumstances that window of time can be extended to four hours. Nevertheless, the time requirements place an enormous burden on machines and men who must function perfectly for a success.

The Gemini will give the astronauts, engineers and doctors the experience of long flights—up to two weeks. The doctors want to be sure that the human body doesn't break down. There are indications that weightlessness and confinement produce calcium loss from the bones, blood pressure troubles and possible—although not expected—mental disturbances.

The long flights mean that the instruments on board will be taking literally millions of measurements and radioing them back to earth to the MSC. Yet it will be only a fraction of the data to be handled in Apollo. To sift the numbers and words, the space engineers have leased five of the biggest IBM computers available—the IBM

7094. The computer complex is so big, it needs a Univac computer just to be a traffic manager for the data flow.

None of these elements of Gemini could have been reproduced by extended Mercury flights, Chris Kraft, assistant director for flight operations, says. Nor would it have been economical or wise to wait for the Apollo orbital missions. Even at $300 million for all the Titan II rockets, Gemini flights represent a bargain in rocketry.

"I couldn't think of a better way to do it," Kraft says.

Of course, in any space program, anticipation of events is treacherous. Delays inexorably creep in. In Gemini, the engineers have done everything possible to prevent delay—although the first manned flight is already many months behind original estimates.

The degree of delay will give some indication of whether the men at MSC can also meet President Kennedy's Apollo deadline by 1970. It's a tremendous job compared to Mercury, and the men at MSC know it. Maxime A. Faget, assistant director for engineering and development, puts it best in comparing Mercury to Apollo.

"It's as if right after Kitty Hawk, the government gave the Wright brothers a contract to fly the Atlantic," he says.

The machine is the Gemini spacecraft, a squat metal cone that can fly loops, barrel rolls and Immelman turns at 18,000 m.p.h. If the Mercury capsules were cannonballs that could be lobbed into orbit with or without a man inside, the Gemini spacecraft are airplanes—useless to the tune of $1.3 billion without skilled human crews.

Less than two feet separate the two men of the crew, but neither can see the other's eyes behind the visor of his space helmet. Accustomed to scanning the instruments of a jet fighter, their eyes dart from pressure gauge to toggle switch then back again to an omnious warning light. Across its plastic cover someone has stenciled the word, "ABORT."

Suppose that moments after liftoff this light glows red.

"Gus" Grissom must reach between his knees and pull hard on a metal "D-ring." Instantly, ejection seats will blow him and his copilot away from the stricken rocket. But if Grissom and Young fail to see the little red light, if their hands do not respond instantly to the glowing cue, the rocket could blow *them* apart instead.

Grissom's D-ring

No one in the concrete blockhouse below can yank Grissom's D-ring. Nor can any ground-lubber steer Gemini when, a few months later, it creeps up on an Agena rocket and nudges this orbiting fuel truck with its funnel-shaped nose.

The astronauts, not the little black boxes, will decide when to abort a Gemini launch. The astronauts, not an autopilot, will perform that most delicate of deep-

space maneuvers: docking one spacecraft with another.

Just as a jetfighter must plug into a tanker before crossing the Atlantic, astronauts on the moon must rendezvous with a spacecraft overhead before crossing the ocean of space between earth and its satellite. They'll learn this trick in Gemini.

With Gemini, for the first time in the space race, the United States has a chance to smash Russian endurance records. On June 19, 1963, Lt. Col. Valery F. Bykovsky set the existing one by spending 119 hours and 6 minutes inside his Vostok 5 spacecraft and orbiting the earth 81 times.

According to the proposed Gemini flight schedule, two American astronauts will do better. GT-5 (NASA's code for the fifth Gemini-Titan launch) is scheduled to spend seven full days aloft. That's 168 hours and 118 orbits to enter in the record book, assuming the Russians do nothing spectacular in the meantime.

The one-week flight and the two-week flight to follow afford NASA medics a chance to perform all sorts of experiments on the Gemini astronauts. In one, they'll attach a microphone to the astronaut's chest and listen to the rhythm of his weightless heart. Is the heart a less efficient pump without gravity?

In another, NASA doctors will feed the astronauts low-calcium foods for two weeks before and two weeks after one of their week-long flights. Before the flight, and again after it, the doctors will X-ray the pilots' heel and finger bones to see whether weightlessness makes bone dissolve. If calcium has disappeared will it not reappear in the form of kidney stones that can paralyze a man with sudden pain?

Physical problems are not the only ones that will be studied in the longer flight. What NASA calls "extra-vehicular" activity will occupy the pilots for only a few hours of the two weeks they'll spend lying side by side. This fact raises a dark psychological question: Can two men under stress continue to get along in such close quarters?

"Preferred" co-pilots

Grissom was allowed to submit a list of "preferred" co-pilots after his selection as spacecraft commander. He was even empowered to veto NASA's choice of a co-pilot, though it never came to that.

Such precautions, obviously, were taken to prevent a personality clash in training or in space. Whether they were necessary is doubtful. From launch to landing, on the shorter flights the astronauts will be kept busy, so busy they'll probably lack time in which to squabble. For one thing, they'll have to fly the spacecraft.

Look inside the cockpit of Charles Lindbergh's "Spirit of St. Louis" as it hangs in the Smithsonian, and you'll see an altimeter almost identical to the one in Gemini. Look inside the cockpit of a first-line jet fighter, and you'll see an "at-

titude indicator" and a control stick that seem to duplicate those in the spacecraft.

Titanium-beryllium bell

From the moment a pilot squeezes into a model spacecraft he assumes he is in a winged airplane — not a titanium-beryllium bell that would seem more at home under water. In fact, Gemini flies like a very stable airplane in absolutely calm air, with two big exceptions.

The control stick of a fighter can be moved in an angular direction, forward and to the right, for example. This would cause it to dive and bank right simultaneously. In Gemini, you can move the stick only one way at a time.

Push it forward and the spacecraft noses down. Twist it with your wrist and Gemini begins spinning like a top. Move the stick directly to the right, and the capsule will roll like a barrel in water. But where the airplane has rudder pedals, Gemini has nothing.

The first men to die in the billion-dollar United States space project called Gemini fell into the bright blue water of the Atlantic Ocean at the end of June. Yet not a single man had left the safety of Cape Kennedy aboard that big, bulky Gemini space ship.

Death took 17 elite para-rescue men, the cream of a special Air Force group that combines scuba diving with parachute jumping. Their planes collided over the picture-book island of Bermuda in the midst of a practice operation.

Leaping from the aiplane, these rubber-suited men were to splash into the water to wrap a huge, inflatable collar—a gigantic version of a child's swim tube—around the 3,300-pound floating Gemini ship. They never got a chance to practice.

But before Grissom and Young, shoot skyward, other frogmen will have perfected the technique. They did it for Mercury. And it now looks as though they will do it for Apollo, the project designed to take three men to the moon and back.

As of this moment, the preferred landing method is by sea, with two

Gemini's first crew, Grissom (left) and Young, look at a scale model of the spacecraft and booster for their mission.

Unlike the Mercury astronauts, the Gemini men will be able to fly their capsule down after the four retro-rockets have fired.

oceans as possible landing areas. So the frogmen must tie the space-age Mae West to the capsules to prevent tipping and waterlogging. It's a must and all part of the complex return-to-earth that men must master.

The moon voyagers will come slamming back into earth's atmosphere at 25,000 miles an hour. That speed puts a lot more heat-stress on their ship than will Gemini's 17,000 miles per hour. And the 10,000 pounds of Apollo weight will need three parachutes as opposed to Gemini's one.

The slide rule men "easily" decided when they could and could not fire an Atlas rocket to shoot the one-man Mercury capsule into orbit. They could afford to draw their schedules, thinking first of the ships and planes that would pluck the astronaut out of the sea.

But the moon mission will have its own constraints. And once a billion dollars worth of men and machine has been made ready for the optimum moon-shot at Cape Kennedy, the mission will go. It will come back when it can, and the ships and planes of Apollo recovery will just have to be there.

That, in miniature, is the problem faced by Donald Stullken, planning commander for the vast NASA recovery force that includes the Air Force planes and helicopters and scuba parachutists and dozens of U. S. Navy ships from corvettes to aircraft carriers.

Along with the Gemini capsule, the "footprint" has grown bigger since Mercury. It now measures approximately 80 by 500 miles. It will be global for Apollo. The footprint, explains Stullken, is the area in which the Gemini capsule may come down after the astronauts have fired their braking rockets to start the searing re-entry into earth's atmosphere.

Rendezvous mission

A two-week Gemini mission doesn't bother Stullken at all. Whether the flight time is scheduled for two hours or two weeks, the engineers' slide rules will have calculated the orbits in which the space ship will barber-pole the globe of earth. The recovery ships can plan to be under these stripes at the right times. What worries recovery is the rendezvous mission in which the Gemini ship must be launched within an hour and a half so it can catch that Agena rocket shot up a day earlier. An hour of time or a needed change in the launch angle can make a huge difference in Stullken's planning, in his deployment of that huge fleet of ships and helicopters all over the world. On a rendezvous mission, the

engineers will be aiming the manned capsule to catch Agena without a care for where it might come down. Later they will be aiming much bigger ships for the moon.

Though the sea rescue of the Gemini astronauts will closely resemble the recovery operations of Project Mercury, the descent through 100 miles of space and atmosphere will be very different. The Gemini capsule doesn't look as if it could glide on inch, but the engineers have been working over the blunt end of the vehicle, the one behind the astronauts' backs that hits the atmosphere first. They have made the heat shield thicker on one edge and arranged the hundreds of instruments and astronaut equipment to put the capsule's center of gravity at a precisely calculated point.

That will enable the astronauts to fly their capsule down after the four retro-rockets have fired.

Stripped down capsule

The flying will be far from exuberant. The capsule will be stripped down from 19 to 11 feet with the dropping of the now useless adapter section and the burnt-out retro rocket pack.

But the small computer, its dials winking with lights and figures, will still be aboard and running the show. Astronauts will know by this time where they want to land. They will punch the latitude and longitude of that point into the thinking machine along with the exact braking the retro rockets have supplied and any information they have on the atmospheric and stratospheric conditions.

With that information, the computer will take over and fire any of eight small rockets mounted around the narrow nose of the Gemini capsule. The puffs of hot gas from these rockets will tip the capsule this way or that while the blunt shield, like a red hot sail, swings them left or right, up or down.

If the astronauts want to fire the rockets themselves, they can, but they must do exactly what the winking computer tells them to. There isn't time in those crucial minutes of re-entry for them to make the complicated navigational decisions which the computer has been pre-set to do in seconds.

Though astronauts Grissom and Young will certainly come down on water unless there is an unexpected emergency, the real stew at MSC bubbles over the possibility of land touchdowns. Not every one in Houston wants to bother with the problems involved. And, in fact, the only hint of controversy at MSC is developing over this point.

A young engineer named John Kiker looks to skid-down landings that might be made so precise that a welcoming band and some local politicians could be on hand for the touchdown.

One factor that argues against nautical recovery is the hob seawater plays with the special metals

If the Gemini and Apollo astronauts are forced down on land, they must be able to take steps to avoid a city or a mountain or high tension lines.

clothing the Gemini capsules. Once that bell-shaped craft splashes into salt water, it is a total loss as far as any further flights are concerned. If this sea-water corrosion were eliminated, it should be possible to fly Gemini capsules over and over, simply by building up the heat shield again where it has lost thickness in the friction-fire of re-entry into the atmosphere.

So there is an issue of economy, with Gemini capsules costing over $35 million apiece. There is also safety. Kiker says it is just a question of time before there will be an emergency on board that will force a Gemini crew to come down fast, without a thought for where. And the prospect on the 500,000-mile moon missions is for even more uncertainty about landing, even as the Apollo engineers calculate on a sea ending to the fabulous tale.

But if the Gemini and Apollo astronauts come down on land, they will have to be able to look down and be capable of taking steps to avoid, say, a city or a mountain or some high-tension power lines. The idea of the capsule, slung under its 84-foot diameter parachute, dropping on the Empire State Building at 30 feet per second is unlikely. But such a landing would be catastrophic for the occupants.

For several years the Gemini engineers have been playing with a chute that looks like a bent air-mattress. Called a Rogallo wing, in memory of its Italian inventor, the mattress utlimately proved impractical for Project Gemini. Storing the vast, inflatable wing in the nose of the capsule so that it would come out rightside up and bring the astronauts down to a controlled bump-down left too many ifs for the engineers' satisfaction.

Kiker thinks he has a better gimmick at hand. It is a close cousin of the parachutes sporting sky-divers use, with slots in its nylon and taffeta that can be opened and closed by astronauts pulling levers down in their capsule.

Steerable parachute

The ability to make a parachute carry you where you want to go was first developed in the late eighteenth century. But the model that intrigues Kiker and his colleagues was devised only a few years ago by a French aerodynamic inventor named Pierre LeMoigne.

With a flap in the rear and slots at its side edges, Le Moigne's parasail carries its load one foot horizontally for every foot it drops vertically. On a windless day, the 80-foot-wide parasail can maneuver as much as two miles from an altitude of only 10,000 feet.

And in tests with the 3,300 lbs. of stripped down Gemini weight slung under it, the parasail burden hit the ground traveling with a vertical component of 24 feet per second. Though that jolt is only three feet per second more than the one a sport parachutist takes on landing, it isn't soft enough for the engineers.

They are now working on a small rocket to be mounted on the underside of the capsule. Triggered by the nearness of the ground, the rocket would fire a two-second burst to ease the final landing. The engineers may even set off that rocket with a three-foot wand to contact earth in those last seconds of the descent.

But if the astronauts are to pull the slot shrouds and steer, their capsule will have to hang so they can look downwards out of those semi-porthole windows. And there will have to be short narrow skis extended beneath the spacecraft.

The trouble with all this is, of course, that skis and parasails and extra shroud lines and pogo-rockets add weight to Titan II's burden at launching. Everything on the Gemini missions must come in sets of two, one to work in case the other one becomes inoperable.

That is the crux of MSC landing and takeoff and safety problems. The engineers, thinking first of the safety of Gus Grissom and John Young, know they cannot put everything they want on board. They must calculate that a parachute shroud cutter in an astronaut's spacesuit pocket weighs three or four ounces, that a combination radio and signaling light in his survival pack weighs a pound.

Our successful test firings of the big Saturn I rocket, far more powerful than Titan II which will launch Gemini, will soon ease the weight problem for the engineers on short-ranging missions. But for the next two years our twins will get only 3,500 pounds of capsule apiece for take off, only 1,650 pounds per man to get home in.

Those stringent restrictions, too, are good practice for the coming moon shot since launch weight on that long voyage will be just as tight a straight jacket.

Project Apollo may ignite the gleam in the astronaut's eyes, but for the engineers at MSC it would be just as exciting to have three more pounds of OK Gemini launch weight to play with.

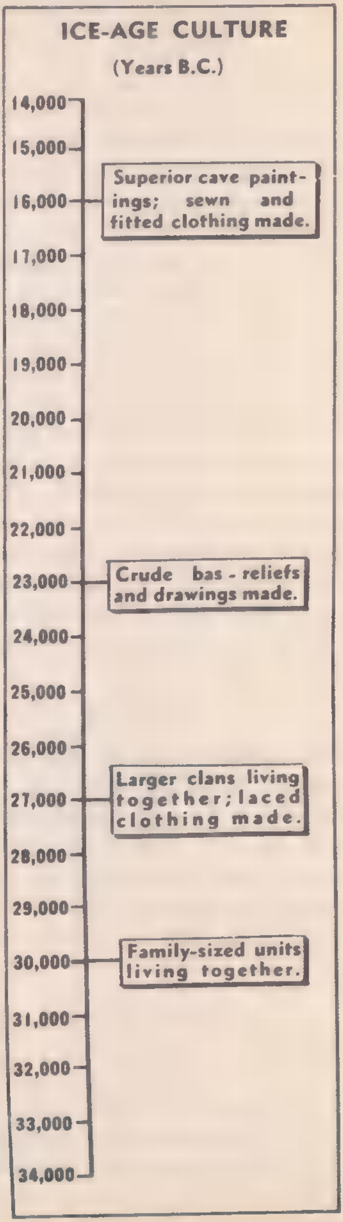
Man takes gravity into space

IF MAN is to stay in space for any length of time, he needs artificial gravity. A NASA-sponsored study reports that an artificial gravity station can be orbited like the whirling South American bola. The space vehicle and an exhausted booster rocket would be joined together and set spinning. The spin through space at 16 feet per second and the orbital speed of 17,300 miles an hour would create gravity in the form of centrifugal force.

The cave man gets a new look

by Walter Sullivan

Chart at right shows the cultural progress of the peoples who inhabited the area of the Les Eyzies, France, excavation.



FROM school texts and comic strips we have a vivid image of the cave man — hulking, hairy, wrapped loosely in skins, but it appears from excavations at Les Eyzies, France that this is false.

They have shown that, during a span of 17,000 years, roughly from 32,000 to 15,000 B.C., at the end of the ice ages, the region was inhabited by a succession of industrious, erect people who thrived despite the hardships of a subarctic environment.

They represent the gradual development of European man from Neanderthal through Cromagnon toward his modern form. While their appearance changed, they probably looked somewhat like the Plains Indians of the United States.

The skeleton of a girl from a layer of earth more than 20,000 years old shows slightly protruding teeth and eyes that slant, though unlike the eyes of Oriental people. Yet, in the words of Hallam L. Movius, Jr., in charge of the dig, "She probably could have passed in New York as a debutante."

Mr. Movius, who is professor of anthropology at Harvard, deplores

perpetuation of the cave-man image. He believes it was born of the prejudice of those who wished to set the Neanderthal man clearly apart from his modern "civilized" counterparts.

Yet actually he was not the stooped, brutish creature so commonly pictured.

Cromagnon man

Nor was the Cromagnon man that came later the ideal Aryan shown in schoolbooks. Here, within a few score yards of where the Cromagnon man was discovered in 1868, students of Prof. Movius are scraping, brushing and picking their way back through the ages, layer by layer.

It is said to be the first such meticulous, many-faceted attempt to trace the evolution of man, his culture and his environment in this region of south central France, known here as "the cradle of prehistory."

So rich is the deposit in the debris and tools of ancient man that the experts are incredulous. Twelve thick layers lie one on the other. They are separated by sterile layers that presumably represent periods when this site, under a widely overhanging cliff, was unoccupied.

By exploiting the techniques of specialists in a variety of fields, much has been learned of how these people lived. Yet some of the most basic aspects of their culture defy explanation.

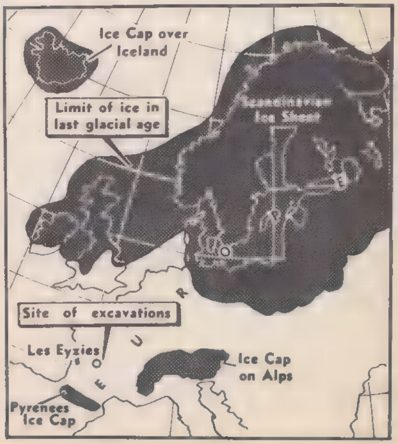
Considering the rapid fluctuations of human culture in recent centuries, the vast period of these ice-age cultures showed remarkable stability. The front of the great ice sheet stretched from Britain across the North Sea to Northern Germany. France and most of Europe were covered with tundra or scrubby forest browsed by enormous herds of caribou.

It was the caribou upon which the ancient culture rested, as shown by the fact that more than 85 percent of the bones in the debris are from caribou.

Thanks to a French expert on caribou it has been possible to conduct a statistical analysis of the caribou foot bones, bringing to light those periods when the ground was marshy and the bone structure was modified accordingly.

The modification apparently was a characteristic acquired by each animal during its lifetime and not passed on to his descendants. Hence

Map indicates the ice pattern in Europe at the time of the last glacial age. Les Ezyies was on the fringe of the ice sheet.



the feet returned to normal when the climate changed again.

A Finnish expert on Arctic pollen is helping to reconstruct the ancient climates. A Dutch physicist is analyzing the decay of radioactive carbon to determine the ages of the various layers.

An American geologist has helped explain the material that separates the layers. This region, the Dordogne, was an ideal haven for ice-age man. Limestone lies in beds of varying hardness. The soft layers erode along the cliff walls of the valleys, leaving hard layers overhanging them.

Since medieval times these overhangs have been walled in for homes or storage. Dissection of their floors has shown that they were occupied far earlier. This ancient culture reached its peak in the Magdalenian period of 15,000 years ago, as manifested in its brilliant cave paintings.

The excavations here deal with earlier periods. After the Magdalenian the ice began to retreat. Heavy forests grew and the caribou vanished. Hence this Eskimo-like culture degenerated. It is not yet known whether these people departed, vanished or were absorbed by others.

One of the most puzzling aspects of the cultures being exposed here is their heavy dependence on tools whose use is a complete mystery. Notable among these are the burins —small flints that were chipped into shape with mass-production uniformity.

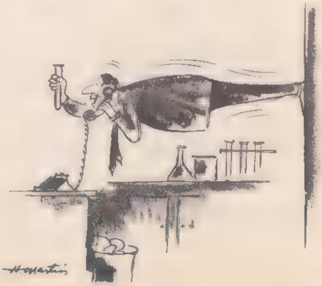
Prof. Movius believes that, to survive the harsh climate, these ancient peoples must have made fitted clothing of some sort, even though the bone needle did not come into use until the Magdalenian. He suspects that the earlier peoples laced their clothes using special flints to pierce the skins and push thongs through them, much as one laces a football.

Analysis of the fireplaces seems to have shown an evolution in social structure. The period of about 30,000 years ago is marked by small hearths, indicating family-sized units like those of the Eskimos. The subsequent periods display gigantic fireplaces 20 feet or more in width, suggesting clan life.

While Prof. Movius is field director of the project, he shares its overall direction with Prof. H. V. Vallois of the Museum of Man in Paris. The project, under way several years, is financed by the National Science Foundation in Washington.

The dig is changing our view of man's past.

"I may be a little late getting home tonight, dear, but I think I'm making headway on my new epoxy formula."



What medical science can do about acne

Acne is not generally a serious health problem. But to the afficted teen-ager it can be the worst problem in the world. It can leave psychological as well as physical scars. An understanding of this stubborn condition and some new medical treatments will help ease many young people through some painful years.

by **Bruce H. Frisch**

SEVENTY-FIVE to 90 percent of all teen-agers go through a bout of acne.

Only in severe cases does it affect general health. It is primarily a cosmetic problem. But this doesn't mean it is a small problem.

"The present-day treatment of acne yields quite satisfactory results in the great majority of patients," claims Dr. Frederick D. Malkinson, dermatologist in the U. of Chicago Department of Medicine.

The major trouble comes because our culture in general, and adolescents in particular, overvalue physical appearance, says Dr. John F. Kenward of the Departments of Pedriatrics and Psychiatry at the U. of Chicago School of Medicine. The teen-ager may also suffer guilt when others take the common attitude that acne is an outward sign of inner badness, or a punishment for "self-indulgence."

An unfortunate few may suffer lasting effects. A team at the Veterans Administration Hospital in Los Angeles studied 15 men who had undergone abrasion treatment (described later) for the removal of severe scarring. Eleven of them felt there had been great improvement, and the team found objective improvement, in the men's self-esteem and personal contacts. Despite improvement, 11 of the men were still considered psychologically abnor-

Dermatologists prohibit chocolate, cocoa, nuts, iodized salt and cola drinks. They also restrict fatty foods, dairy products and sweets.

mal, six seriously so. Acne, the team concluded, had "left permanent scars on the psyche."

The reverse may be true also, and already-existing emotional problems can become entwined with a case of acne. Dr. Kenward even finds some evidence that emotional conflict may contribute to a case of acne. In spite of the social handicap under which acne puts him, a patient may resist treatment. He may not want to advance into the adult world without a ready-made excuse for failure.

The outcome is expressed in a medical saying recalled by Dr. Kenward: "One cannot put beautiful skin on unhappy people."

Improving the skin

For people who are simply unhappy about their skins, there is a definite hope for improvement. The root of the problem is at the root of the hair, as explained by Dr. Allan L. Lorincz, from the Section of Dermatology, Department of Medicine, U. of Chicago. Here the sebaceous glands empty oily sebum into the hair's sheath in order to keep the hair soft and pliable. During adolescence, a hormone imbalance causes the sebaceous glands to enlarge and secrete excessively. Oily skin results, but alone does not lead to acne.

For reasons that are not clear-cut, the next step is for the cells of the sebaceous gland duct to die and turn to horny keratin, the material that makes up the dead, top layer of our skins. The duct becomes clogged with horny material, sebum and other debris. When the horny material oxidizes, it blackens, turning the plug into a blackhead. Large blackheads rarely progress further.

Small blackheads form around rudimentary hairs that are always in the resting stage of growth. These may become inflamed, and a red bump rises into a pimple. The particular kind of hair around which a pimple develops grows thickest on the face, followed by the back, shoulders, neck and chest.

Organisms in the plug may cause some pus formation, but secondary infection from other sources, such as dirt on the skin, does not necessarily occur, although it is "not rare." In the course of the disease the surrounding structures, including the sebaceous glands, are destroyed.

Susceptibility to acne seems to run in families, and boys get it worse than girls. Few cases continue beyond the age of 30.

The amount of scarring depends on the depth and intensity of inflammation, picking and individual predisposition to the formation of scar tissue.

When it comes to treatment, there are few measures upon which most dermatologists will agree, probably because there is no single, one-shot cure. From the responses of 1,151 dermatologists to a questionnaire on acne treatments, Dr. Charles L. Schmitt, Assistant Professor of Dermatology at the U. of Pittsburgh School of Medicine, compiled this summary:

For simple acne (blackheads and pimples), prohibit chocolate, cocoa, nuts, iodized salt, and cola drinks, and restrict fatty foods, dairy products and sweets. Prescribe vitamin A, and for certain female cases, estrogens, or female hormones. Instruct the patient to wash with soapless, medicated cleanser; apply a drying agent; use a shampoo to correct oily scalp. Treat with ultraviolet light.

For complex acne, where pus or cysts have formed, administer tetracycline antibiotic internally. Add limited X ray; hot, moist compresses; cryotherapy and staphylococcic vaccine.

Chocolate gets vetoed

Only five percent of the dermatologists absolutely prohibit all sweets. The most-prohibited food was chocolate, voted down by 77 percent. Most other treatments on the list are used by fewer than half the physicians.

Let's see how each treatment applies to the different stages of acne.

Hormone imbalance is the underlying cause of acne, yet hormones have proved a poor cure. Estrogens have been mainly successful only in special cases where girls have an outbreak near their menstrual periods. Dr. Malkinson, in a symposium held by the *Illinois Medical Journal*, reported inconclusive results with estrogens in doses small enough to avoid bad side-effects. He warns against applying hormones locally to the skin, because too much is readily absorbed.

Physicians who prohibit foods believe that a hormone imbalance predisposes the sebaceous glands to oversecretion, but that the glands need additional stimulation from the diet. Dr. Malkinson finds this questionable.

Keratinization of the sebaceous gland duct is the next development in acne. Here is where vitamin A is aimed. Massive doses are supposed to inhibit keratinization. Dr. Malkinson has found the results disappointing, and cites the possibility of vitamin A intoxication.

Horny keratin and sebum soon plug the gland duct and become a blackhead. This brings on inflammation, and up pops a pimple. At this point a dermatologist will probably order the most widely accepted maneuver, a combination of cleaning and drying. Physicians answering Dr. Schmitt's survey named 106 different cleaning preparations they prescribe. Soap placed fifth, and soap and hot water is what Dr. Malkinson tells his patients to use three times a day. Some of the other preparations may contain a detergent and hexachlorophene, a mild

antibacteriacidal often found in deodorants and deodorant soaps. Soap and detergent remove oil from the skin. Hexachlorophene is meant to lessen inflammation and infection resulting from bacteria on the surface.

In conjunction with cleansing, a lotion is applied to dry the skin and unplug the sebaceous gland ducts. The Schmitt survey unearthed 122 different ones. The latest is a disappearing lotion to give girls the fashionable "natural look."

A typical product might contain calamine and zinc oxide for drying and keratolytic agents such as sulfur, resorcinol, salicylic acid or strongly alkaline soaps. Keratolytic agents dissolve the keratin plug. Since the outer skin is also keratin, it flakes away too. This is what strong soaps do to the hands, so the treatment may be said to give dishpan face.

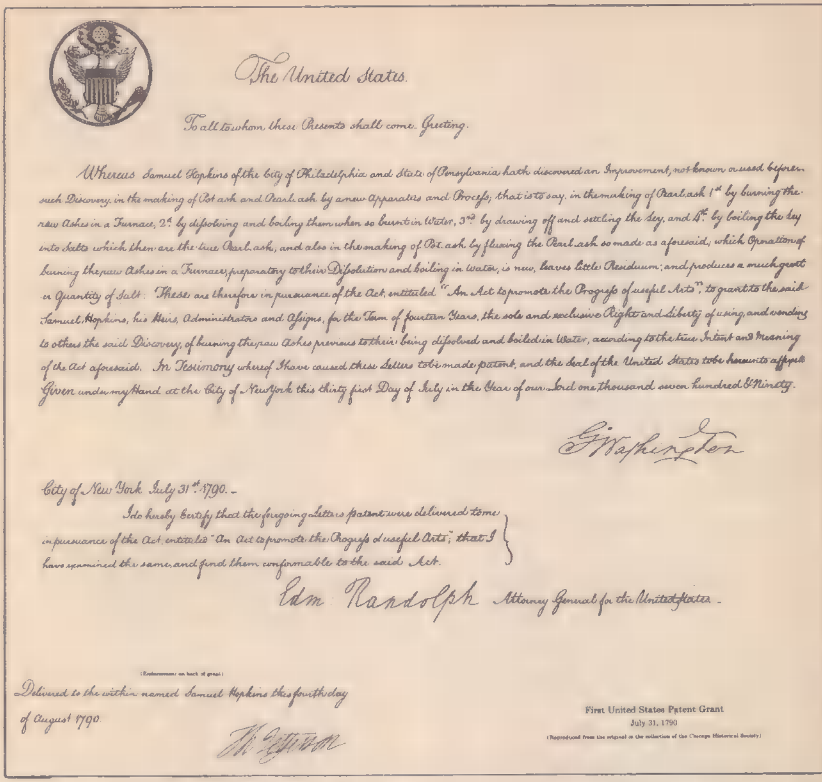
This is an old, established method. Dr. Schmitt says, "The aim of local therapy in acne patients, as far back as 1824, was to stimulate and peel the skin. The purposeful effect of treatment has not changed in 139 years." Modern science has, however, developed some new ways to induce peeling.

It is a common experience to have acne clear up temporarily after a summer outdoors. Investigators found that the effective agent was the ultraviolet portion of sunlight which dries and scales the skin. Dr. Malkinson starts off with a one-minute session under an ultra-violet lamp and builds up to a ten-minute maximum. Overlong exposure may prematurely age fair skin.

If acne becomes infected, the physician may rush in with antibiotics. Sometimes, says Dr. Malkinson, it is difficult to hit the right bacteria. A broad-spectrum antibiotic will attack many different kinds at once, but, Dr· Malkinson cautions, the treatment can stretch out over an expensively long time with possible side-effects. Smearing antibiotics directly on the skin, he has found, "has proved to be of little value."

Today it is possible to literally grind away the old face and its scars and grow a new one with dermabrasion. The tools are small wire brushes and toothed, stainless steel wheels turned up to 30,000 rpm with a dentist's belt drive. The physician first sprays a small area with Freon refrigerant to firm the flesh, anesthetize and delay bleeding. He follows close behind with the cutter, making short strokes perpendicular to the rotation to prevent grooving. Ten to 14 days later, the serum crust drops off to reveal rosy new skin. The fresh areas may remain pink for months or years, or may be permanently white in older patients. Skins shaded between fair and very dark may not recover full pigmentation.

Luckily, after years of drying, freezing, irradiating and grinding, nature takes its own corrective measures. Most adolescents, says Dr. Kenward, emerge from the acne years unscathed cosmetically and psychologically.



The United States.

To all to whom these Presents shall come Greeting.

Whereas Samuel Hopkins of the City of Philadelphia and State of Pensylvania hath discovered an Improvement, not known or used before such Discovery, in the making of Pot ash and Pearl ash by a new Apparatus and Process; that is to say, in the making of Pearl ash 1st by burning the raw Ashes in a Furnace, 2d by dissolving and boiling them when so burnt in Water, 3rd by drawing off and settling the Ley, and 4th by boiling the Ley into Salts which then are the true Pearl ash; and also in the making of Pot ash by fluxing the Pearl ash so made as aforesaid; which Operation of burning the raw Ashes in a Furnace, preparatory to their Dissolution and boiling in Water, is new, leaves little Residuum, and produces a much greater Quantity of Salt: These are therefore in pursuance of the Act, entituled "An Act to promote the Progress of useful Arts", to grant to the said Samuel Hopkins, his Heirs, Administrators and Assigns, for the Term of fourteen Years, the sole and exclusive Right and Liberty of using, and vending to others the said Discovery, of burning the raw Ashes previous to their being dissolved and boiled in Water, according to the true Intent and Meaning of the Act aforesaid. In Testimony whereof I have caused these Letters to be made patent, and the Seal of the United States to be hereunto affixed. Given under my Hand at the City of New York this thirty first Day of July in the Year of our Lord one thousand seven hundred & Ninety.

G. Washington

City of New York July 31st 1790.

I do hereby Certify that the foregoing Letters patent were delivered to me in pursuance of the Act, entituled "An Act to promote the Progress of useful Arts"; that I have examined the same, and find them conformable to the said Act.

Edm: Randolph Attorney General for the United States.

(Endorsement on back of grant)

Delivered to the within named Samuel Hopkins this fourth day of August 1790.

Th: Jefferson

First United States Patent Grant
July 31, 1790
(Reproduced from the original in the collection of the Chicago Historical Society)

George Washington authenticated the first patent, a potash-making apparatus, in 1790.

The invention lag

by Stacy V. Jones

THE AVERAGE American regards this as an age of unprecedented production and technological progress, and assumes that inventions set the pace. Yet, as measured by patents, Yankee inventiveness has been slowing down for many years.

As the American patent system approaches its 175th anniversary, economists have been studying our rate of invention with a critical eye.

George Washington signed the first patent law, "An Act to promote

Patents have failed to keep pace with the population and they do not reflect the big growth of industry or funds for research.

the Progress of useful Arts," on April 10, 1790. Later that year, he authenticated the first U.S. patent, for a new apparatus and process used in making potash.

In that first year, only three patents were granted. Nowadays the weekly grist frequently exceeds a thousand, and nearly 3,200,000 have been issued since 1790. But that doesn't tell the full story.

Inventions decreased 1/3

The late Frank A. Howard of Standard Oil Company (New Jersey), speaking at a Washington meeting in 1960, surprised his audience of educators and lawyers with the assertion that "the per capita output of inventions of our . . . . people has decreased perhaps more than one-third in the last generation." He pointed out that from 1930 to 1958 the population had grown about 45 percent, but the number of patents had increased only 7 percent. The per capita output seemed to have declined by about 38 percent.

Howard's figures caused a good deal of thumbing of census reports. The per capita patent output today is indeed lower than it was in 1870, and the trend has moved jerkily downward for 75 years.

The United States granted 229 patents per million population in the fiscal year ended last June 30. Since the middle of the 19th century, the patents per million Americans in census years have been:

1850	38
1860	139
1870	305
1880	257
1890	403
1900	324
1910	382
1920	352
1930	368
1940	321
1950	286
1960	265

Not only have patents failed to keep pace with the population, but they do not reflect the enormous growth of industry or the colossal increases in expenditures for research and development.

It is true that the raw statistics leave out the intangible factor of quality. Today's patents are not comparable with those of a century ago, nor are they comparable with one another. One may be for a laser, another for a magnetohydrodynamic machine and a third for a coat-hanger. Because they are issued in the same week and take about the same space in the Patent Office *Official Gazette*, can we give them equal weight, or are we trying to add apples and fish?

The patents issued in the 1960's

do have a certain general character considerably more sophisticated than that of the 1860's. The simple mechanical improvements have been succeeded by horizon sensors, rocket propellants, intricate electronic instruments, new compositions of matter (chemicals) and even a couple of new elements—americium and curium, for which patents were issued in November and December.

The professors who study patents for the Patent, Trademark and Copyright Research Institute of George Washington University contend that our inventiveness is at least holding its own. They assert that present-day inventions not only cost more in time and money but produce more in profit; that 60 percent of today's patented inventions bring revenue; that there has been a progressive improvement in quality during the 20th century and that many remain in commercial use for decades. They point to the increasing proportion patented abroad as well as in this country as evidence of higher value.

A spokesman for the National Science Foundation ascribes what he calls the decline in the importance of the patent system to a change in the methods of research, which he terms a sign of the times, and not necessarily an evil. Instead of the 19th century trial-and-error efforts of single inventors in attics, we have the institutional approach. Research and discovery are programed and directed by the Government, the universities and industry.

In 1839, according to tradition, Charles Goodyear accidentally dropped a piece of rubber mixed with sulphur onto a hot stove, and found that it charred rather than melted. This gave him the key to vulcanization, and enabled him to pay off his accumulated debts of $35,000. A little more than a century later, the transistor was discovered in a manner quite different, although perhaps also touched by serendipity. At Bell Telephone Laboratories, a group of scientists were investigating the properties of semiconductors such as germanium, and noticed phenomena that attracted them to new experiments.

Lab succeeds kitchen

Just as the laboratory has succeeded the kitchen as the birthplace of inventions, the corporation has succeeded the independent patent owner. In 1790, of course, all inventors were independents. As late as 1901, four patents out of five were still being issued to individuals, the fifth going to an employer. The research laboratory had just been born. Today, the proportions are almost reversed; seven out of 10 patents are issued to corporations. Although some of the inventors may be outsiders who have sold their ideas, the majority are assumed to be scientists and engineers on the laboratory payrolls.

Many "captives" produce inventions working solo, but a large volume of patents is the output of lab-

Patent figures do not necessarily gauge the country's inventiveness, but inventors might be more productive if adequately rewarded.

oratory teams of from two to four men (and occasionally a woman). In an unusual case, a single patent issued in 1963 to the National Cash Register Company, for a computer to handle complete accounting for a small business, bore the names of 21 inventors.

An executive of a pharmaceutical house said recently that although an important vaccine patent was granted to two men, the credit really belonged to about 60 people. One large oil company avoids giving individual publicity to inventors on its payroll, feeling that the staff as a whole should be recognized. Many corporate news releases about patents omit all reference to the inventors.

In carefully planned company research, with large numbers of technicians involved directly or indirectly, one patent often results instead of a number that might have come from random efforts.

Another reason ascribed for the declining per capita patent output is that inventions are harder to make. The courts and the Patent Office have raised the standard of invention that they require the examiners to follow in granting applications. And technological advances and competition demand ever more complex devices and processes.

Industry has found several reasons for using fewer patents. Some concerns try out new products on the market early and, if they do not show promise, do not bother to patent them.

Patent protection

Others have learned that certain things do not need patent protection. With a trademark and a heavy advertising campaign, they can blanket the market for a new household item. If the competition comes up with something similar, it doesn't particularly matter.

"Defensive" patents are taken out by companies so that others cannot prevent them from using a process or making a product. But through disclosure in a technical paper, limited protection can be gained without a patent.

Even for giant corporations, patents are slow and costly. The average period from filing to issuance is more than three years. At present, the Patent Office has a backlog of more than 200,000 pending applications.

Not counting the laboratory work, big companies usually estimate the cost of getting a patent at from $1,000 to $3,000.

Besides that, the annual expenditures of about $20 billion for research and development, of which the Government's share is about $15 billion, do not produce a propor-

tionate volume of patented inventions. Of the relatively few that do result, only a small fraction have commercial application.

The professional concentration on defense and space is illustrated by a statistic in a recent report of the Senate Small Business Committee: Of the 400,000 scientists and engineers doing research and development work in this country, 280,000 are engaged on Government space or military programs.

Such reasons are a valid explanation for the proportionate drop in the number of patents issued in recent years. But even those observers who contend that patents are better than ever and that there is no actual lag agree that we ought to have more invention. Maybe we're doing all right, they say, but we ought to do better.

Many employed inventors admit that they might be more productive with adequate rewards and recognition. Employment contracts usually require the assignment of rights to patents conceived as part of the job. Although some companies make cash payments, others merely take inventions into account in granting promotions.

Another deterrent to invention is corporate inertia. Big companies resist innovation (which is a Ph.D. word for putting inventions to work), and thus do not invite new ideas.

"Since 1956," an engineer recently commented, "I have worked for manufacturing corporations, reporting to a vice-president and sitting on committees concerned with new products. I conclude, inescapably, that there are serious, almost hopeless, barriers to the introduction of really new products inside an organization that has a large investment in personnel and capital equipment which are specific to the manufacture of old products.

"This, I am sure, accounts for all the mergers. Acquisition has become almost a standard method of adding a new product to a company's line."

The drop in patents may mean largely a shift from amateur to professional, from basement to laboratory, but we cannot afford a net loss in inventiveness, which has been described as probably the most important dynamic force in economic growth and national defense, essential to the country's position in the international race for power and prestige.

Invention and innovation

The U.S. Department of Commerce, parent of the Patent Office, has set out to stimulate both invention and innovation. Its missionary efforts to make industry more receptive to change have been started through joint programs with communities, universities and bar associations.

The department has also been discussing with universities the arrangement of engineering courses that will turn out men and women who are not only inventors but entrepreneurs, knowing management

problems and capable of putting ideas to work.

Stronger incentives for inventors can be provided by the companies that employ them or buy their patents. More than a third of the employed inventors queried by the George Washington Institute indicated that they would welcome some tangible remuneration besides salary. Some mentioned bonuses, others royalties or percentages of sales. Less tangible inducements suggested were freedom of research, a favorable creative environment and professional recognition.

Employe-inventors

The National Inventors Council has proposed modification of the Federal income regulations, authorizing corporations to capitalize special rewards to their employes. The employe-inventors could then report the payments as long-term capital gains, instead of as regular income.

The task of cutting the three-year wait for patents is primarily the province of the Patent Office itself. A technical staff has for years been trying to turn the job of searching prior patents and publications over to computers, but has found no breakthrough. The examiner must conduct such a search of the foreign and domestic "prior art" to satisfy himself that an invention is new and therefore patentable.

Some progress has recently been made through an international committee. Each of a number of patent offices will record its own data in certain technological fields on punched or notched cards, and exchange sets with the other offices.

Even the founding fathers found examining patents burdensome. In 1790, the work fell on three busy officials: Thomas Jefferson, Secretary of State; Henry Knox, Secretary of War, and Edmund Randolph, Attorney General. Three years later, the examination system was dropped in favor of mere registration. It was restored only in 1836.

Laws unchanged since 1836

The present patent laws have remained essentially unchanged since 1836, but the country has not. It is little wonder that the patent system shows signs of wear and fatigue. The executive branch is just beginning a survey looking toward a major overhaul.

The prospect of reducing patent costs is not bright. Two bills were introduced in the recent Congress to change the fees, but upward. Hearings brought out strongly vocal opposition, and both failed.

If the 200,000 backlog and the triennial wait cannot be eliminated by staff efforts, Congress can offer relief. One method that has been discussed is adoption of a system of delayed examinations like that inaugurated in 1964 by The Netherlands. The application is published but if, after seven years, neither the inventor nor anyone else applies for an examination, it will lapse.

Now—a hormone that melts away fat

Lipotropin may eliminate crash diets. It is a hormone that can change solid fat in the body to a liquid, which is then eliminated naturally.

by Sandy Spillman

HORMONES, which influence the way we look, feel, think and act, may now help us lose weight fast—without dieting and exercise.

Lipotropin, a new hormone, amazingly changes solid fat in the body into a liquid, which is then eliminated naturally. Discovered at the Berkeley campus of the University of California, the hormone opens up a tremendous new avenue of hope for those overweight.

Lipotropin is a joint discovery of Dr. Choh Hao Li, Director of the Hormone Research Laboratory at the University; Dr. Yehudith Dirk of Israel's Hebrew University; and Phoebe Lohmar, a young National Science Foundation predoctoral Fellow.

The hormone is so new its effects on the human body are still unknown. With its use weight might be melted off in rapid order, but what side effects may result can't yet be predicted. Furthermore, the hormone is tremendously expensive to make. It is derived from the pituitary glands of sheep. The tiny glands from 1,500 sheep add up to only two pounds. From this amount of material an extract containing the hormone is made. The extract is then put through a chemical process to precipitate the hormone into pure form. The result is a mere fraction of an ounce.

Soon, however, the hormone's structure will be completely analyzed, and its fat-dissolving element synthesized in the laboratory. Such a "man made" version of Lipotropin will then be available in quantity, at a reasonable price. This has already been done with many other hormones.

"Finding out exactly how a hormone is put together," says Dr. Li, "is somewhat like trying to learn every single detail in the structure of a great castle containing, let's say, a thousand rooms. You have to know the precise dimensions of all the windows. Are they round? Are some of them square? What type of glass is used? And what is the exact sequence of all the rooms? How is each put together? This kind of

Dr. Choh Hao Li's discovery, Lipotropin, has met all experimental requirements for identification as a new hormone of the pituitary gland.

analysis must take place before you can even begin to think about duplicating it."

Nevertheless, Dr. Li is convinced the problem will be solved, as he has done with other hormones. The doctor has successfully "tailor made" ACTH (AdrenoCorTicoptropic Hormone), the medically valuable protein hormone used to combat arthritis and other ills. It was while trying to develop a faster way to isolate ACTH that the new Lipotropin was accidentally discovered.

Dr. Li and his colleagues were surprised to find an unknown substance pop up in their tests. A series of chemical studies showed the new material to be different from any other pituitary hormone. They found this new molecule to be a single chain of 59 amino acids, arranged in a specific but still unknown sequence.

Lipotropin has now met all experimental requirements for identification as a new hormone of the pituitary gland. Through tests on fat pads of rabbits the catalytic process has been found, and the powerful fat-releasing properties of the hormone isolated. The achievement marks an important advance in scientific technique, for this is the first hormone to be discovered by a purely chemical approach. The scientists actually reversed the classical method of biochemistry. They isolated the substance and studied its chemical properties before they investigated its biological effects.

Dr. Li, who has been probing the pituitary gland, and seeking out its elusive hormones for a quarter of a century, is the world's outstanding researcher in this field. He and his laboratory teammates were the first to isolate most of the pituitary hormones. HGH, a Human Growth Hormone, that Dr. Li and his colleagues found, is now being used at the University's Medical Center in San Francisco. There, children suffering from severe dwarfism are under treatment with HGH, and their growth is being stimulated successfully. Other hormones inhibit the growth of certain cancers, correct sexual, menstrual and menopause difficulties, and, in fact, determine in countless ways what we will be like from childhood to old age. They affect us mentally as well as physically. A case was reported by Prof. Peter Forsham of San Francisco:

"I had a housewife with dermatomyositis (a skin inflammation) who had been taught how to play the piano when she was little. She had continued for the entertainment of the children, but didn't get very far. When she started on large doses of ACTH she was suddenly able to play the most difficult works of Beethoven and Chopin—and the neighbor children would gather in

the garden to hear her play. But she became a little psychotic, and so her dosage of ACTH had to be lowered. With every 10 units of ACTH one sonata disappeared. It all ended up with the same old music poorly performed."

Hormones are not drugs, but glandular secretions in our bodies. The amounts and quality of hormones our glands pour into us every day affects us emotionally as well as physically. The thyroid gland, for example, secretes substances that control the rate of metabolism in the body. People with underactive thyroids are sluggish, torpid and eventually may become mentally retarded, because their cells are running in "low gear." Conversely, people with an overactive thyroid are nervous and jittery because their cells are racing.

One of the best known hormones is insulin, which promotes utilization of sugar in the body.

Other hormones control sexual and reproductive functions and regulate the development of the characteristic features of each sex.

The study of hormones is not new. At the turn of the century two English physiologists, William Bayliss and Ernest Starling, became intrigued by a certain performance occurring in the digestive tract. The pancreas releases its digestive fluid into the upper intestines at exactly the moment food leaves the stomach and enters the intestines. The question was: How does it get the message? What tells the pancreas that the right moment has arrived?

In those days, the only known means of communication in the body was the nervous system. The obvious guess, then, was that the information must be transmitted by the nerves. Presumably the entry of food into the intestines from the stomach stimulated nerve endings which relayed the message to the pancreas via the brain or spinal cord.

Bayliss and Starling decided to test this theory. To do so, they cut every nerve leading to the pancreas —and got a surprise. The pancreas still secreted juice at precisely the right time. The puzzled experimenters searched for an alternate signalling system, and tracked down a substance secreted by the walls of the intestine. When they injected this "chemical messenger" into an animal's blood, it stimulated the secretion of pancreatic juice, even though the animal was not eating. The two investigators concluded that food entering the intestines stimulates the linings to secrete the substance. This then travels through the bloodstream to the pancreas, triggering the gland to give out with its juice.

Bayliss and Starling named the substance secreted by the intestines secretin, and they called it a hormone, from the Greek word meaning to "rouse to activity."

Other researchers discovered that an extract from two small organs just above the kidneys—the adrenals—raised blood pressure if injected into the body. A Japanese chemist, J. Takamine, isolated the

key substance and named it adrenalin. As the years went by, investigators found that other glands in the body also secreted hormones.

But what was it, they wondered, that controlled all these varied and powerful hormones? All of them can exert drastic physiological effects. Yet so harmoniously are they tuned together that they keep the body working smoothly without a break in rhythm. Seemingly, there must be a conductor somewhere that directs their performance.

The answer was found in the anterior pituitary, the gland that keeps all the other glands playing in time and in tune. This "master gland" in man is about the size of a pea, suspended just below the center of the brain. Its location suggests that it is under direct control of the brain, but how this control is exercised is still only partially understood. What has been established, according to Dr. Li, is that hormones produced by the anterior pituitary control growth, sexual development and reproduction, thyroid activity and the body's general response to stress and disease. The pituitary is a veritable chemical factory which controls and correlates many of the vital life processes of the body.

Why do people get fat? Very often what seems to be hereditary isn't. Nearly always it is due to eating more food than is needed. An entire family may be fat because they have all been brought up on fattening food. The greatest life expectancy occurs in persons who are slightly overweight up to age thirty, and of average weight from thirty to forty. Thereafter, they live longer if they are underweight.

There is no specific vitamin or diet that is good for everybody. Some vitamins and diets may even be harmful. Your age, sex, physical condition, occupation and glandular balance determine a correct diet for you. Like any other machine your body needs certain foods, such as starch and sugar for fuel, proteins to rebuild tissues that are lost through wear and tear and fat for emergencies when the proteins and carbohydrates run low.

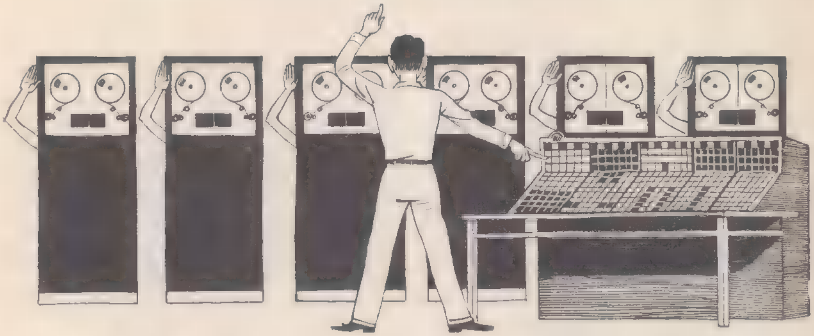
Vitamins and minerals maintain a normal and complete metabolism, the chemical expression of life. Usually, the body uses only the amount of vitamins it needs, and eliminates the excess. Fundamentally, every disease is a disease of metabolism.

Overeating doesn't always mean eating a lot of high-calorie, fattening foods. Overeating means eating any kind of food which contains more calories than your glandular system can handle. That's why some people who eat a lot and don't exercise still never gain weight.

Fifty years ago people ate more than we do now, yet obesity is on the increase. We eat more and better food than any one else in the world, yet most of us worry about gaining weight.

Dr. Li's hormone, Lipotropin, when synthetically made and available, will help solve a dilemma of the times and eliminate drastic weight reduction methods.

What is a computer?



The machine that is revolutionizing our lives isn't as difficult to understand as many people may believe. Here is a simplified explanation.

by Ken Kizer

COMMERCIALLY speaking, the Electronic Data Processing (EDP) industry is only a scant 12 years old, and its chief product, the computer, is fast proving the faith placed in it by manufacturers and users alike.

In relatively simple, everyday language and concepts, just what is a computer, or data processing system?

Computers come in two categories: analogue and digital.

The analogue computer *measures*, much as a slide rule translates logarithms into physical distances or the speedometer of an auto indicates miles per hour. First of the computers to be made, it is used primarily for industrial processing. But, like the slide rule, analogue devices have a limit to their possible accuracy.

The digital computer *counts*, never responding to a greater or lesser degree but operating with discrete (separate) signals that either exist or do not exist. It is this system of electronics that is the primary concern of business today.

A digital computer—or electronic data processing system—is nothing more than an amalgamation of components which, when properly linked together by electronic circuitry, can tell the difference between a square hole or the absence of one in a punched card, a round hole or none in punch paper tape, an electrical current or no current, pulse or no pulse. It is capable of a limited number of operations, e.g., it can

A digital computer basically does nothing but count and remember, at fantastic speeds. There is nothing it can do unless man tells it to.

add, subtract, multiply, divide and compare. It also has a "memory," or the ability to store information, in the form of numbers which it can apply to certain tasks it is called upon to perform.

Grouping of metal cabinets

Externally, a computer is a grouping of metal cabinets linked together by electric cables to make up a system. Within these cabinets are electronic assemblies, sub-assemblies and modules. For instance, in a typical RCA 3301 data processor of average size there are some 70,000 individual components ranging from the largest printed circuit board, measuring about 50 square inches, to transistors the size of an aspirin tablet, to ferrite memory cores as tiny as a grain of sand.

Data processing, reduced to everyday example, is writing a check and balancing the stub preparatory to writing another check, or peering into the refrigerator and noting that the egg supply needs replenishing by a dozen. By simple definition, it is counting.

A digital computer accomplishes its counting job by using only two digits—zero and one.

Although this may appear strange to the person who has been trained to read and think in terms of ten digits, the two-digit, or binary, system is quite practical since the computer operates on the basis that there is a pulse (one) or there isn't (zero). The following combination of zeros and ones illustrates how a computer counts from zero to nine:

0000 — 0	0101 — 5
0001 — 1	0110 — 6
0010 — 2	0111 — 7
0011 — 3	1000 — 8
0100 — 4	1001 — 9

Obviously, utilizing this method, a computer cannot, in fact, multiply or divide in the sense that nine times nine equals 81, or that 25 divided by five equals five. The computer multiplies by adding nine to itself nine times, or divides by subtracting five from 25, five times.

Speed

The most important fact about a computer is not that it can record and remember numbers but that it can quickly yield these numbers in forms of data suitable to move from one part of the system to another. The "pulse, no pulse," or "hole, no hole" *modus operandi* makes it easy to transfer these data from one form to another. Data become a pattern of signals or pulses of electricity which, in turn, becomes a pattern of opened or closed switches or conducting and nonconducting transistors.

Processing data is taking a suc-

cession of facts, applying them to a formula and obtaining new, up-to-date information in some meaningful and useful form. It means solving at high speed a simple or extremely complex mathematical formula. Actually, the computer can absorb any record-keeping or mathematical problem that can be reduced to a routine procedure.

If one keeps in mind that a digital computer basically does nothing but count and remember, speed, then, is the main advantage of the electronic data processor over the human brain. The computer cannot do a single, solitary thing unless man tells it to. The only trouble is that man can't live long enough to figure out some of the problems a computer can do in a few seconds.

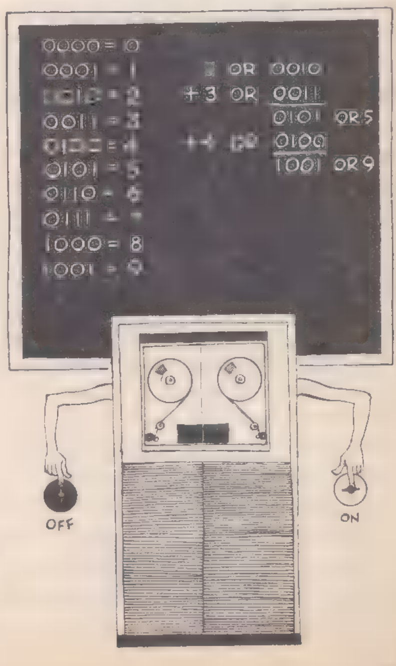
A computer is elementary, so elementary that man must define precisely each step that the computer must take in order to solve even the simplest equation. These definitive steps are called a "program," and the man who figures out these steps is known as a "programmer."

After the computer is equipped with the necessary program, it can be directed to execute the instructions comprising the program, normally in a sequential manner. That is, the computer starts with the first instruction and progresses serially through the program.

A simple instruction might be: Multiply A by B, divide by C, and compare the result to D. First, this instruction must be converted to a machine language the computer can understand—something like "2108-1259650." The computer reads this instruction and in less than a second multiplies A by B, divides by C, and compares to D—a job that would take a person using pencil and paper several minutes to figure out.

Functionally, the computer is divided into five basic categories—input devices, output devices, memory, arithmetic-logic unit and control.

The computer can use only two digits—zero (switch is off) and 1 (switch is on). It multiplies by adding very rapidly. (Note: In binary arithmetic, where 1 is directly under 1, the sum is zero, and 1 is carried to the next column on the left. If there is already a 1 in that column, the sum is zero again, and the 1 carries through to the left again.) Man's life span isn't long enough to figure out some of the problems that a computer can do in a few seconds.



For the sake of clarity, computer functions can be compared to the daily functions of a business office, complete with secretary.

Input devices to a computer would be magnetic tape reader, punched paper tape reader, punched card reader, communications lines, or even the output of other computers. In an office, inputs would include the telephone, mail delivery, teletype, or the "in-basket."

Computer memory

Computer memory is its storage unit augmented by a "scratchpad" device, magnetic tape, punched cards and/or punched paper tape. The "memory" is the secretary and her experience, files, "hold basket," calendar and memos she keeps on her desk.

The arithmetic-logic unit of a computer is its capability to add, subtract and so on, plus the ability of the machine to make the correct decision in the face of alternatives, which corresponds to the secretary's brain. The same would be true of the control unit—an electronic "traffic cop" that governs the flow and priority of the data in the computer much as the brain goes from one step to another in daily office routine or procedure.

Output devices of the computer are punch paper tape, magnetic tape, punched cards, printed matter, and the like. The "out-basket" for pickup, directed telephone calls and hand-delivered memos are the output of the secretary.

A secretary's daily output is small compared with the output of an electronic data processor. In fact, a computer could simultaneously schedule production, analyze sales, keep inventory, compute bills, figure payrolls, report costs and estimate budgets, among other secretarial chores.

Because it can do all this and because it can read, write and do arithmetic with tremendous speed and accuracy, the computer is revolutionizing not only office work but also industry control as well as giving a new dimension to management intelligence.

Peripheral equipment

Coupled with peripheral equipment such as magnetic tape units, high-speed printers and readers, random access memories, paper tape readers and punchers and the like, a computer system becomes quite sophisticated, permitting people to do a variety of jobs they were unable to do before.

But there is no magic involved. Before an electronic data processor can utilize its millionth-of-a-second speed, man must tell it exactly what to do and how to do it—step by step.

This is the first of a series of articles on computers. In succeeding issues, we will discuss, in layman's language, what different types of computers do and some of the latest models that are now or soon will be available.

Why men smile

Human facial expression is not a simple thing. The origin of a smile or a frown is deeply rooted in the gestures of our primate ancestors.

Foes of Darwin's theory of evolution often referred to him as a master infidel, entirely novel in his folly and wickedness, a purveyor of ideas that no Christian had or ever could entertain. Undaunted by these attacks, Darwin continued his investigations and extended his theory in an attempt to discover precursors from which human expressions might have evolved. In 1875, *The Expression of the Emotions in Man and Animals* reported his comparative survey of facial expressions in primates and other animals, but other researchers showed only a sporadic interest in this area until the 1930's. Soon thereafter, many began to appreciate the importance of the subject and the new approach it offered to some problems of human evolution and behavior.

The primates, from whom material for most comparative surveys are derived, evolved as six separate lines during the Tertiary period. They are Tuparoidea (tree shrews), Lorisoidea (galagos and lorises), Lemuroidea (lemurs), Ceboidea (New World monkeys), Cercopithe-

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coidea (Old World monkeys and baboons) and Hominoidea (apes and man). Perhaps these investigations will someday answer questions like, "Why do men smile or laugh to express friendliness or pleasure, rather than make some other equally arbitrary gesture?"

Message of the features

Some possible answers to questions of this sort were reviewed by Dr. R. J. Andrew of Yale University in *Science*. He points out that, "Facial expression has evolved, like other displays, to communicate information about the probable future behavior of the displaying animal." For example, flattening the ears, closing the eyes and withdrawing the corners of the mouth, are gestures that probably originated as protective responses. *Galago crasisicadatus* reacts in this manner when it is faced with some potentially dangerous object. Domestic cats, with their relatively mobile faces, may only retract the corners of their mouths under similar circumstances. The less confident the animal, the greater the distance from threat at which such a response will occur. Therefore, one may expect these responses to yield information about the animal's social status and its likelihood of approach.

Ear flattening is the conspicuous protective gesture in Lorisoidea and Lemuroidea. While it also occurs in both monkeys and baboons, scalp retraction becomes an obvious part of the movement. Scalp retraction is most marked in baboons, macaques and mangabys, probably because the prominently colored skin which is normally hidden by the eyebrow ridge or topknot of hair, suddenly appears. This gesture is also thought to be a protective response, evoked under circumstances similar to those that cause ear flattening.

In man and apes, scalp retraction is absent, or of minor importance. Some observers believe that this is because of lessened mobility of the ears in both men and apes. Although lower mobility may be a factor, it seems more likely that scalp retraction is undeveloped because it is a response incompatible with the important gesture of eyebrow lowering. Old World monkeys react to threat by first lowering the brows—a response that is quickly replaced by scalp retraction if the threat is intense. Threatening situations are more likely to cause man and the chimpanzee to lower the eyebrows and at the same time draw them together.

One of the most important components of facial expression is the contraction of a mouth muscle, the orbicularis oris, during vocalization. It has been suggested that this rounding-of-the-mouth evolved from suckling movements, since it is seen in monkeys and apes when physical contact is desired. Such contraction may also occur when vocalization involves lusty expiration. For example, the gesture is displayed when the deer lows, the dog howls, or the lion roars. Similarly, the human

A grin means more than pleasure. Like chimps and gorillas, man retracts his lips markedly when he's afraid, frustrated or excited.

child may protrude his lower lip prior to crying.

Retraction of the corners of the mouth into a "grin" is widespread throughout the animal kingdom. Grins usually indicate one of three intentions—a hard bite with the back teeth for defense or eating, a defensive reflex to startling stimuli, or impending vocalization. It has been suggested that the human grin derives from a biting movement. Dr. Andrew says that this idea is only partly valid, however, because "the history of the grin is too complex for so simple an explanation to be adequate."

All kinds of grins

Lemurs may grin in connection with wails of frustration or calls of defense. In more advanced animals, grins are quite easily provoked in a variety of situations. Rhesus monkeys have been observed to grin in silence when they were greatly frightened. Spider monkeys and woolly monkeys will often grin and make crackling noises when they are getting slightly roughed-up in play.

Marked retraction of the lips is seen in man, chimpanzees and gorillas during fear, frustration, or great excitement. According to Dr. Andrew, "A similar expression occurs in 'moderate anger' in the chimpanzee, perhaps because of a tendency to shriek." At such times, the motivation of the chimpanzee is obscure.

Man may display a grin during confident attacks, but shrieks are more likely to accompany the grin during aggressive tantrums. While man may grin silently while fighting, he may also grin during purely physical exertion. Other primates, instead of grinning, may raise the lip and close the eyes when attempting to overcome a physical obstacle. "It is likely that these are protective responses," said Dr. Andrew, "related to the concentration of attention on the obstacle and the lack of precaution against possible injury when it yields."

Social interaction between men often evokes smiles that are probably protective in origin. Thus, the smile that one may assume when under verbal or other attack by a superior, is related to the grin of stress when laboring over delicate machinery. The grin evoked in primitive mammals by startling stimuli is related to the smile of infants during "peek-a-boo" games.

The relationship between smiles and feelings of pleasure were explored by Dr. R. N. Haber a few years ago in the *Journal of Experimental Psychology*. Dr. Haber believes that human subjects judge

small changes in stimulation to be pleasant while big changes are judged to be unpleasant. One might then assume that jokes evoke smiles of pleasure or amusement because the essence of the anecdote is the right degree of discrepancy between the real ending and the anticipated ending.

Lip-smacking monkeys

Lip-smacking, tongue movements, and heightened facial mobility is found in all the fully social primates. Young macaques and baboons smack their lips when seeking physical contacts with their peers. They also display lip-smacking in greeting and as a part of the grooming behavior. Old World monkeys and baboons smack their lips in some of the same situations in which human beings smile. Man and the apes do not lip-smack although Dr. Andrew notes that "protrusion of the lips to grasp an object may take its place to some extent."

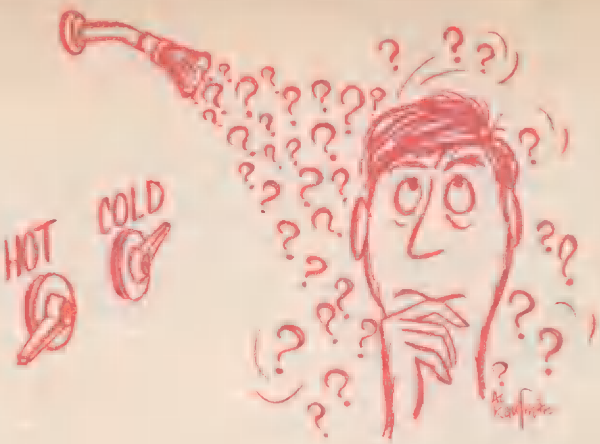
There is some evidence that man's ancestors may have evolved the more exaggerated use of grooming movements of the lips and tongue. Since that time, there seems to be a trend toward increased facial mobility in primate evolution. Undoubtedly, the growing need for conspicuous gestures, capable of carrying an increased amount of information, has been of great importance. As noted by Dr. Andrew, ". . . it is the highly social mammals which have exaggerated facial displays. This is clear when we compare wolves with the expressionless and solitary bears. . . ."

Whether or not the progression of facial mobility is caused by increased socialization, as suggested by Dr. Andrew, it is very clear that comparative surveys offer an excellent means for studying the evolution of behavior. Few authorities would disagree when he says, "The parallel evolution of displays which has occured in these different lines (primates) is of much interest and is likely, with further study, to prove very revealing of the sort of selective pressures that are involved in such evolution."

The young marrieds

THE majority of this year's marriages will be between teen-agers, according to the Population Reference Bureau. If parents want to keep their daughter from making an impulsive marriage, the best step is to get her into college in a hurry. Statistics say that a college career delays a girl's marriage for four years, on the average.

But even undergraduate marriages are much more common than they used to be, and in the major colleges, only the armed services' academies rule them out. Almost one-fourth of the students graduating this year will be married students, many of them with their youngsters watching them get that degree. Thirteen per cent of this year's June graduates were expecting to marry before the end of the summer.



Hot and cold quiz

by John and Molly Daugherty

A SCIENCE exhibit that opened in Chicago the first of this year features a do-it-yourself chamber in which you can try out different environments—heat, cold, odor, color, etc.—by pushing a button. Before you push any buttons, what do you know about heat and cold?

1. Which process enables you to stand a desert temperature of 120°F?
   a. Radiation
   b. Evaporation
   c. Conduction

2. When you walk barefoot from a wool carpet to a tile floor, the tile feels colder even though the temperature of the two floors is the same. Which process of heat transfer is the reason?
   a. Convection
   b. Radiation
   c. Conduction

3. Which contains the most heat energy?
   a. Dry ice
   b. Ice cubes in your drink
   c. Liquid air

4. Heat and temperature are sometimes confused. Heat is
   a. The total kinetic energy of the molecules
   b. A weightless substance
   c. The average kinetic energy of the molecules

5. Vacuum bottles keep cold drinks cold for about 24 hours, but hot ones hot for only about 12 hours. Why?
   a. The vacuum prevents conduction of heat
   b. No air between the walls prevents convection
   c. The shiny surface of the inner container reduces radiation.

6. Which process of heat transfer makes your fireplace burn?
   a. Conduction
   b. Convection
   c. Radiation

7. Put one of your hands in a pan of hot water. Put the other in a pan of cold. Keep your hands submerged until they get used to the water temperature, and then quickly submerge them both in the same pan of lukewarm water. How do they feel?

a. Cold
b. Hot
c. Hot and cold

8. Which one of these may be called a cooling process?
   a. The melting of ice
   b. The boiling of water
   c. The condensing of water vapor

9. Which one-pound pan requires the most calories of heat to raise its temperature 1°C.?
   a. An aluminum pan
   b. A stainless steel pan
   c. A copper pan

10. When you are outside on a cold winter day, what is the *chief* process by which you lose body heat?
    a. Radiation
    b. Conduction
    c. Convection

Answers:

1—b Evaporation. The evaporation of your perspiration cools you off. The usual methods of transfer of heat from your body by radiation, conduction, or convection are useless because your surroundings are hotter than you. Evaporation is a cooling process. The heat required to evaporate perspiration comes from your skin. In desert heat, you may perspire a gallon a day. Men in desert oil fields perspire even more. The evaporation of a gallon of water takes about 2,344,000 gram calories (2,344 food calories).

2—c Conduction. Heat is conducted away from the bottom of your feet on the tile floor, giving you the sensation that the tile is cooler than the carpet. Wool is a poor conductor of heat. Most of the heat from your feet stays right under your footsteps.

Metals are such good conductors of heat that children have been known to have their tongues freeze to a metal fence which they've licked on a cold winter day.

3—b Ice cubes. Ice cubes at freezing (32°F.) are much higher in temperature than dry ice (–110°F.) or liquid air (–312°F.). Although specific heats differ, in general the colder a given substance is, the less heat energy it possesses. Only at absolute zero, which is –459°F. (–273°C.), would all substances cease to possess heat energy.

4—a Heat represents the total kinetic energy of molecules. The motion of molecules may be translational, vibrational, or rotational. Temperature, sometimes called the intensity of heat, is the average random translational motion. To heat a small room to 70°F. obviously requires less heat energy than heating a large auditorium to 70°F., yet the temperature reads the same.

That heat could be a weightless substance was part of an early Caloric theory, now replaced with the concept of heat as a form of energy in the kinetic-molecular theory of gases.

5—c The shiny surface. Take hot coffee. The shiny surface of the inner container reflects radiant heat from the coffee back to the coffee. The vacuum does not prevent radiation of heat. In spite of the reflecting surface, however, some radiation takes place, and the coffee eventually cools off. When you fill the bottle with hot coffee (212°F.), the contrast between

the temperature inside and 70°F. outside is great. When you fill the bottle with iced tea (32°F.), the contrast between the temperatures inside and outside is small. The greater the temperature differences, the greater the rate of heat radiation. Of course the same reflecting surface reduces the rate of radiation coming from the outside to warm the iced tea.

6—b Convection. After you've started the fire, the air immediately above it is warmed and expands, becoming less dense. The air in the room, cooler and denser, moves toward the fireplace to push the heated air up the chimney. To say hot air rises is incorrect. Gravity pulls on hot air as well as cold, but the cold air exerts greater pressure and moves toward and under the hot air to push it up. Convection occurs only in liquids and gases.

7—c Hot and cold. The lukewarm water seems cold to the hand which has been in hot water, but it seems hot to the hand which has been in cold water. You feel both effects at the same time. The skin has receptors for warmth and other receptors for cold (the absence of heat). In this experiment both are stimulated.

8—b The boiling of water. It takes a lot of heat, about 540 calories, to turn one gram (1/454th of a pound) of water into steam. The heat to do this must come from the pan of boiling water, thus cooling it. Continued application of heat energy is needed to keep the temperature up to the boiling point (212°F.). Turning up the heat doesn't increase the temperature after the boiling point has been reached. The melting of ice requires the addition of heat. The condensation of water vapor or steam gives up the heat acquired when water turns to vapor or steam.

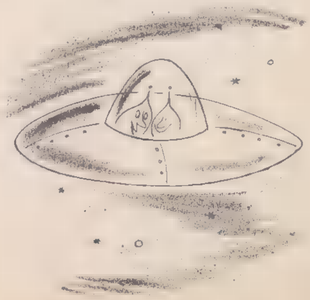
9—a The aluminum pan. To raise one pound of aluminum 1°C. takes about 100 gram calories. The stainless steel pan takes 50 calories; the copper, only 42. If you pour one pound of water into each pan, however, approximately 454 calories are needed to raise the temperature of the water alone 1°C.

10—a Radiation. Since you are warmer than your surroundings, you radiate heat. Your clothing tends to reduce the radiation loss. Some conduction of heats takes place, too, especially if the humidity is high. Dry air is a poor conductor of heat. If it is windy, the wind literally carries heat away from your body. This is convection.

Score yourself:

9 - 10 right—Your knowledge of heat is neat!
4 - 8 right—Lukewarm
0 - 3 right—Not so hot a score!

"Want to start a flurry of U.F.O. reports?"



The Hugh Downs Column

Artificial inspiration

TWELVE years ago, I was lost for a time in the mountains at the southern end of the Medicine Bow range in Wyoming. Since I was lost less than four hours and since no distress or discomfort attended the incident, the word "lost" may not quite be suitable. Daniel Boone's answer to the question of whether he had ever been lost in the wilderness was that he had not, although he was once "uncertain of my position for four days."

On the occasion of my being uncertain of my position, I had a good saddle horse and a pack horse with considerable supplies. The only things I lacked were the rest of my party or the direction to take to rejoin them. Being more or less continually short on solitude, I regarded the episode as refreshing. It gave me, in fact, a feeling of well-being and invincibility.

This feeling may not be thoroughly unreasonable for brief moments and in certain circumstances, but it is in essence false. Human invincibility (even for short periods of time) is a relative thing. Our dependence on certain narrow conditions is more blatantly clear the

more we widen out to consider the range of conditions of our universe.

Life in any form must huddle in tiny enclaves of safety. Places providing the narrowest slices of temperature and pressure ranges, and the smallest doses of radiation are the nooks and crannies in which life can exist. And however tough we think we are, we cannot sever our umbilical connections with Terrestrial Nature, from which we require a steady flow of chemicals containing key elements, without which we should unquestionably perish.

The three principle key elements are carbon, hydrogen and oxygen.

The human animal will starve in a matter of weeks, he will dehydrate in a matter of days and he can be suffocated in minutes. In other words, we can coast only a few weeks without food, a few days without water and a few minutes without air.

The key element in food is carbon, since this atom allows fantastically complex combinations with other elements, building enormous and subtle molecular systems. The key element in water is hydrogen, forming with oxygen a chemical that remains liquid in the temperature range of life and also acts as a solvent and a binding agent. The key element in air is of course oxygen, the cause and support of energy-release through combustion. We are then only weeks away from death for lack of carbon, days away for lack of hydrogen and minutes away for lack of oxygen.

Carbon, hydrogen, oxygen. Put them all together, they spell sugar (or alcohol, or carbohydrate), a word that means the world to all of us.

Now that we've dwelt on our need for the shelter of certain narrow circumstances and on our dependency on these three elements, let's look closely at the last element and the manner of our acquiring it.

Ancestors from the sea

Our remote ancestors surely came out of the sea. And oxygen dissolved in the water was adequate to their metabolic rate. The lung no doubt developed when life discovered that ready quantities of loose oxygen in the atmosphere could aerate blood paraded past a membranous surface.

Two questions occur: (1) Since water is H_2O, why didn't early life in the water contrive to extract the oxygen from its surroundings? (2) Why can't human beings take oxygen from the water they drink and free themselves from the immediacy of breathing and the attendant disorders of a lung system of oxygenating blood?

In answering the first question, it must be made clear that fish do *not* take oxygen from the water they live in. Fish get their oxygen from free air dissolved in the water, but the chemical bond between the hydrogen and the oxygen in water is not disturbed. To dislodge the oxygen chemically from

On land, at sea level, we move around at the bottom of an ocean of gas that puts a pressure of 14 pounds on every square inch of our surface.

water would take enormous quantities of energy. So obviously the lung came about for reasons of economy.

The second question is very interesting in light of man's recent acquisition of great amounts of power. It is technically within the scope of science to liberate oxygen from water and to re-charge the human bloodstream with that oxygen. But the oxygen thus freed would have to be passed through some kind of lung (natural or artificial) to do the job. If the human body were ever doctored up to take oxygen from water put into the stomach by drinking, we'd be surprised at the amounts of water we'd need if we abandoned breathing. With moderate exertion, an average diver uses about 60 cubic feet of air in a half hour (at sea-level pressure). Clearly we'd never get away from the drinking fountain.

This is not to say that some future scuba diver might not take along an electrolysing kit of some sort and take breathing oxygen out of the water he dives in, but the reasons should be clear why Life didn't try this method in its organisms as they evolved.

So lungs are necessary. Some questions remain concerning extreme conditions tolerable to human health. For example, why can we survive an increase in pressure of the gas we breathe of 150 lbs per square inch, but cannot endure a drop of more than nine lbs per square inch? (With altered oxygen ratio it has been demonstrated that an increase of more than 300 pounds is possible, but a drop of not more than eleven pounds.)

On land, at sea level, we move around at the bottom of an ocean of gas that puts a pressure on every square inch of our surface of about 14 pounds. If we go under water with breathing apparatus, we will double that pressure at a depth of 32 feet and add an atmospheric pressure (14 lbs) every 32 feet we descend. Since liquids are virtually incompressible, we retain the same size and shape even at extreme depths (an inflated sealed balloon will not), and while the pressure increases and the molecular count per volume of air in our lungs rises, we can still tolerate considerable pressure. (Note to the tyro diver: While you can stand ten atmospheric pressures briefly, great dangers attend going to such depths—over 300 feet—nitrogen narcosis, oxygen poisoning, air embolism and bends. Great fun can be had in less than 100 feet of water, and the decompression timing is not as critical.)

Now to the other extreme (drop in pressure): To drop the fourteen pounds we have at normal sea-level

conditions would bring us to zero, so our question about human toleration of pressure change, in light of the numbers involved, is somewhat spurious. But let's look at what happens as we move up from the earth's surface and the pressure goes down.

As the air gets thinner, there is less oxygen by molecular count in each lungful of air, and there is less pressure to force it into the blood. At about three pounds per square inch the pressure is not sufficient to force any oxygen at all into the blood, even if the air breathed is pure oxygen.

Therefore, not only is it necessary to have oxygen in the lungs in order to get it into the blood, there must be oxygen at more than a certain pressure. At less than a dozen miles, the air is so thin that another phenomenon takes place and that is that the boiling point of water (and of human blood, which is largely water) coincides with the normal body temperature of 98.6 degrees Fahrenheit. Without a pressurized atmosphere around a human being, his blood literally boils and he will blow apart like a steam boiler.

So empty space is not a hospitable environment for man. Being empty, it does nothing to cushion hostile radiation or fast moving meteorite fragments, and its temperature and pressure are both absolute zero. The space suit is pressurized then, not only to provide breathable atmosphere at pressures under which oxygen will go into the blood, but to provide enough pressure on the surfaces of the body to prevent the blood from boiling.

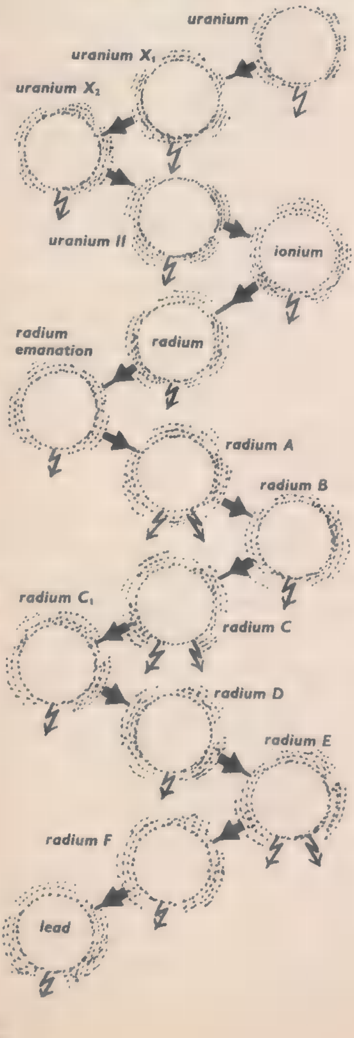
It might be wondered why unconsciousness by anoxia due to excessive altitude is not accompanied by any feeling of distress (as contrasted with holding your breath too long, where the longer you hold it the more anxious you feel and the more desirous of breathing). Curiously this is not because of a lack of oxygen but rather because of a presence of carbon dioxide in the lungs. Anoxia from high altitudes, drowning, or breathing an inert gas such as pure helium, is characterized by a lack of unconscious breathing on the part of the victim. Artificial respiration becomes necessary to save these victims, since natural respiration will not come into play unless there is already some carbon dioxide in the lungs.

Space travel will mean carrying everything along. This might seem one of the formidable obstacles in mankind's path into space, since such tremendous quantities of air are necessary even for a day's breathing. Of course, oxygen can be reused by liberating it from the compounds it forms, but any long-range space vehicle must have muscular power plants aboard in order to pry that oxygen loose.

The hopeful sign is that man does seem to be acquiring more and more power. Like Archimedes' lever, it should eventually enable him, if not to move the world, then to move himself to other worlds.

SCIENCE ABC's

Radioactivity—Atoms with too much energy



Over millions of years uranium, through radioactivity, changes into a whole family of elements, and finally into lead.

RADIOACTIVITY was not discovered until 1896, and then only by accident.

Henri Becquerel (1852-1908), a French scientist, kept a collection of curious minerals in his desk. It so happened that in this desk were several boxes of unopened photographic plates. One day he had reason to open one of the boxes and discovered that the plates were not only fogged, but intensely exposed. He found the others much in the same condition, and quite useless. After studying these happenings, he found that they must have been caused by rays given off from a mineral labeled "Pitchblende from Bohemia." Further investigation showed that the rays could pass through solid substances, such as thick dark paper, and that they could make gases good conductors of electricity, just like X-rays, which were discovered only a year before.

These new rays, unlike X-rays, needed no special equipment to produce them. It was found that the heavy elements—uranium, thorium,

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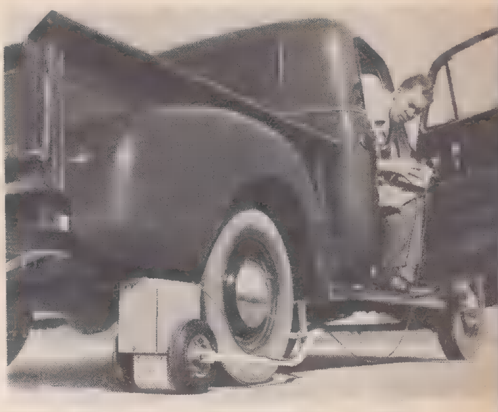
actinium—gave out these radiations even when they were heated or cooled. In fact, the radiations went on naturally, and were quite unaffected by any chemical or physical action. This strange discovery was called "natural radioactivity," and scientists soon came to believe that the reasons for these happenings were to be found deep inside each atom of the substance.

Becquerel placed a piece of uranium inside a lead block, leaving only a thin groove to allow the escape of the radioactivity. By using a magnet, he showed that the radiations were of three different kinds. One was caused by negatively charged particles which the magnet bent to one side, and another kind was formed by positively charged particles, bent by the magnet in the opposite way. The third form of radiation was not bent in any way. The radiations carrying positive charges were called "alpha particles," which were later shown by Lord Rutherford to be the positively charged cores of helium atoms. The negatively charged particles were found to be fast electrons, and were named "beta rays." The rays that were not bent by the magnet were discovered to be X-rays of very short wave length, and were called "gamma rays."

These strange happenings attracted the attention of Marie Curie (1847-1934), the wife of a French scientist named Pierre Curie. She thought that the radioactivity inside uranium (a metallic element in Becquerel's pitchblende) was caused by some other chemical element. She obtained large quantities of pitchblende from the mines of Joachimstal in Bohemia, and after much patient work she produced a very small amount (a few milligrams) of a mysterious element. This substance gave out a bluish glow at the bottom of a test tube, and because it shone like this, the Curies called it "radium." It was found to be a million times more radioactive than uranium, but gave out alpha, beta and gamma radiations like uranium. The Curies and other scientists discovered that since beta particles were fast electrons, and since they were very much smaller than atoms, that the atoms inside radium were breaking up.



Radioactive tracers incorporated in tires are used by industry to measure tire wear.

For a time the discovery of radium overshadowed the importance of uranium, but later English, American and other scientists made careful studies of uranium and these showed that there was a whole family of radioactive elements. Gradu-

ally the truth was revealed, uranium itself was very unsettled and unstable. Its atoms had too much energy inside them and this surplus or extra energy was released in the form of radioactivity. The alchemists of the middle ages had dreamed of turning, or transmuting, elements from one to another, especially base metals into gold. Little did they know that uranium was turning, by natural radioactivity, into a whole family of other elements.

In uranium, then, there are a number of elements, each breaking down by natural radioactivity into elements of smaller weight. During 4,500 million years half the atoms in uranium change into uranium X_1 atoms by ejecting subatomic particles. Again uranium X_1 gives out beta radiation, and half its atoms

Dating the past with radioactivity

When radioactive substances decay, they give off their radioactivity in a very definite way. In a certain period of time (depending on the particular radioactive substance), one-half the radioactivity will be gone; after another interval of time, three-quarters, and so on. Right after World War II, it occurred to an American nuclear physicist, Dr. Willard F. Libby, that the decay of radioactive substances could be used as a "clock" for telling how old fossils and relics of prehistoric man are. All you have to do is find a radioactive substance connected with the relic in some way, and measure the proportion of radioactivity left.

Several such methods of "radioactive dating" have been devised. Dr. Libby himself invented one of the most important, radio-carbon dating. Radio-carbon dating can be applied to materials which, like wood, contain carbon extracted from the atmosphere. All plants absorb carbon dioxide from the air, and their woody parts may be preserved for a very long time, so that radio-carbon dating is usually done with fragments of wooden buildings and the wooden handles of tools, or even the charcoal from fires, which have been saved by burial for several thousand years.

It so happens that the cosmic rays in the upper atmosphere sometimes break up nitrogen atoms, converting them into a radioactive form of carbon. Ordinary carbon is known as carbon 12, but the radioactive kind is carbon 14, and this changes back into nitrogen at a rate which

change into uranium X_2 in the course of 24 days. Uranium X_2 breaks up into another element and this goes on until radium is formed. Radium breaks up, and there are further atomic transmutations until finally natural radioactivity stops and lead is formed. Thus there is a whole series of changes going on in uranium, and the changes stop with lead. The first change from uranium to uranium X_1 takes longest.

When an atom of radium gives out a radioactive ray, it loses a tiny bit of weight. The lost weight, which has been measured, appears as energy. The discovery that radioactive atoms generate energy as they give off rays helped start the science of nuclear energy.

Radioactive substances have a

can be very accurately measured. A small proportion of the carbon dioxide in the atmosphere—about one part in a million-million—contains carbon 14 atoms, and the wood of trees and other plant tissues contain it in the same proportion. It can just be detected with a very sensitive Geiger counter.

Now, the carbon-14 atoms go on breaking up even when they form part of the wood of trees, so that the age of a piece of wood can be found by seeing what proportion of carbon 14 is left in it. Methods of concentrating it, so that very minute quantities can be measured, have been perfected, and it is known that wood which has lost half its carbon 14 must be about 5,000 years old. If it contains only one-quarter of the original proportion it is 10,000 years old, if only one-eighth it is 15,000 years old, and so on. Modern methods are accurate enough to date a piece of wood to within the nearest hundred years, but cannot go back more than 40,000 years.

Radio-carbon dating has been successfully used to fix the dates of early settlements of American Indians, and to check the traditional dates in the history of ancient Egypt and Assyria. It has now become almost a matter of course for archaeologists to send Stone Age and Bronze Age relics to the laboratories for dating by the radio-carbon method.

To date objects older than 40,000 years by their radioactivity it is necessary to make use of some other element than carbon. Periods as far back as 100,000 to many millions of years have been estimated by making use of the slow change of radioactive potassium into argon. Unfortunately most of the other elements are useful only for dating rocks that are millions of years old, so that there is a big gap in radioactive dating. The most satisfactory method for dating very old rocks depends on the fact that uranium changes slowly into lead. This change takes place so very slowly that it can be utilized only for rocks that were formed between 70 million and 4 billion years ago.

number of important uses. Doctors use radium to destroy cancers. Radioactive substances found in rocks or relics of prehistroic man can also be used to find out how old the rocks or relics are (see box). Paints containing a tiny bit of radioactive material and a substance that radioactivity causes to glow are used for self-illuminated watch and clock dials.

In addition to the naturally radioactive substances, there are many in which radioactivity can be induced by bombarding them in an atom smasher or placing them in an atomic reactor. Many of these "radioisotopes" (as they are called) are extremely useful. Thus, cobalt-60 can be used in place of radium for treating cancer. Patients with cancer of the thyroid gland can be treated merely by swallowing a bit of radioiodine; the radioiodine will find its way to the thyroid gland, where its beta rays can attack the cancer.

Radioisotopes can be used both in industry and in scientific research, too. Since radiations passing through thin materials are stronger than those passing through thick materials, radioisotopes can be used to measure the thickness of steel plates and other metal objects. Or a bit of radioactive material can be incorporated in tires or engine parts. Then the amount of wear can be studied by measuring the radioactivity in particles worn off. Radioisotopes can also be mixed with fertilizer and traced with a Geiger counter to see what happens when plants take up fertilizer; or they can be mixed with food to trace what happens to the food eaten by animals. There is literally no end to the uses to which radioisotopes can be put.

"There's no chance of human error here!"

LETTERS

Reading in 30 hours

What an amazing device that reading machine is *(Learn to Read in 30 Hours,* Oct. '64). It shows how much more effective is learning by doing than by being told. We always seem to learn better by trial and error. In fact, isn't it the only way we *ever* really *learn?* Anyone who says the age of automation is no good is saying he's stupid. Let's welcome at least those machines that help us realize our full potential. Given the best teacher, no doubt a child could learn to read as fast as the children in the test you report. But there aren't enough "best teachers" to go around. Not only is the machine patient as almost no human being can be as a child tinkers his way to learning, but it also knows how to spell, which is more than you can count on with many teachers!

JEROME BARWOOD
New Orleans, La.

Down with Darwin

The article, "The Future of Man" (Oct. '64), stated, "Whatever our animal ancestors looked like . . ." It seems that a number of scientists and clergymen still believe in the theory of evolution. Evidently, they do not understand science and theology.

Modern biology has proved that all cells are not alike. The cells of birds, fishes, animals and man are totally different. Protoplasm differs according to the species. The various organs in the human body alone will not take the cells of another organ. Only special creation has the explanation for these phenomena.

It is scientifically established that ova, the spermatozoa, chromosomes and the embryo are different in every species.

Resemblance does not presuppose relationship. On the surface, it appears that man is similar to the ape. Some biology books in the hands of our students clearly picture the sequence of man's supposed evolution. Life is in the blood, not in outer or structural materials.

How can scientists and clergymen alike justify a belief in a theory which is not scientific and certainly not scriptural?

HENRY LISTIAK
Phoenix, Ariz.

Kudos

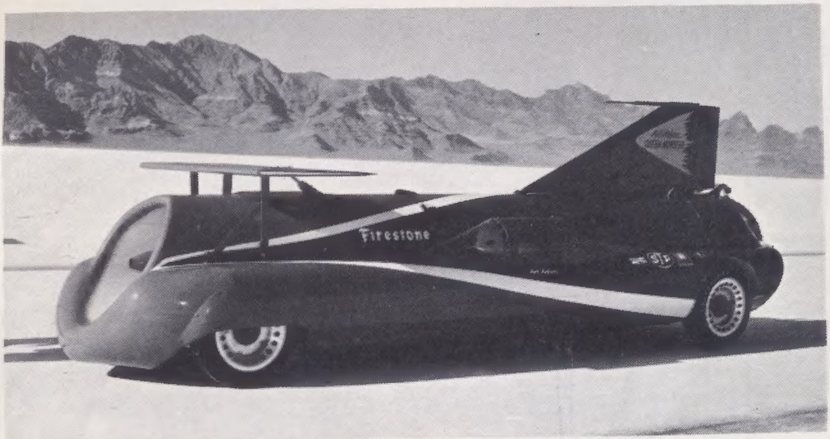
In your Oct. '64 issue you had an article, "Olympic Records . . . Where will they end?" I enjoyed it so much I decided to write this letter to you expressing my feelings.

MIKE KOLIN
University of Michigan
Ann Arbor, Mich.

I very much enjoyed the article, "Science's Exciting New Frontier," by Sanborn C. Brown, in your Oct. '64 issue.

MALCOLM W. SLATON
Russellville, S.C.

Jet engine on wheels



Four times last fall, the world land speed record fell. In three weeks, before the rains turned the Bonneville (Utah) Salt Flats to mush, the mark rose 123 mph. It had inched up only 13 mph since 1947. Sliding in on top with a popped tire and a shredded braking parachute was the Green Monster, the economy compact of the record breakers.

British industry had sunk $10 million into Donald Campbell's 1963 record-holder. A half-million dollars of tire and gasoline money had gone into Craig Breedlove's Spirit of America. But Art Arfons, an Akron, Ohio, professional drag racer, had pieced together his Monster with $10,000 of his own money plus a $50,000 gift set of tires and wheels from Firestone and some free aluminum from Alcoa. He carted his creation to the flats in a resurrected bus.

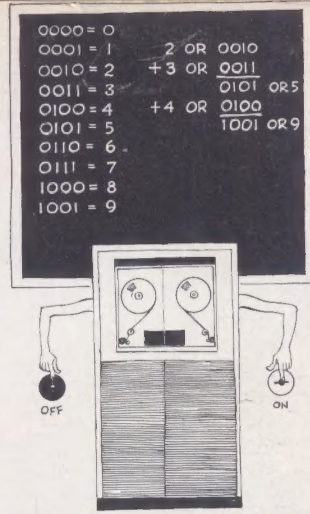
The car is an Air Force surplus J-79 jet engine—"it got surplus by mistake," says Arfons—cradled in a tubular frame with wheels. At its rated 17,000 pounds thrust, the engine puts out 23,000 horsepower when going 500 mph. To prevent the car from taking off, Arfons linked a stubby wing to the front wheels. When the wheels lift off the ground, the wing pitches downward as if in a dive. A fin at the rear helps keep the car going in a straight line. Disc brakes and two parachutes ejected by sawed-off shotguns bring it to a halt.

The record ride started out with a disappointing first run of only 516 mph. On the return, Arfons cut in his afterburner to hit a two-way average of 536.71 mph.

In this issue . . .

A glass submarine has been made possible by a compound that forms the sphere you see here. For the story of its applications and other late inventions and processes, turn to page 11.

This man's name—Lysenko—has risen and fallen with the political barometer in the U.S.S.R. For his post-Khrushchev status, see page 45.



The complex things computers can do often confuse the layman. But you can know their basics. See page 75.

One of the most significant scientific ideas of the times came to this man when he was sitting on a park bench. His name is Charles H. Townes, inventor of the maser and laser. Last month, it won him the Nobel Prize in physics. For the story of how he prepared for the revelation and how he perfected it, see the article, Park Bench Scientist. . .But, which begins on page 42.

Feeling cold? Maybe you don't really know how to dress warmly. Research has shown that it isn't just a matter of how much you wear, but what. See page 34.